Vol. 8 **January, 1953**

The Farm Equipment Industry in Soil Conservation
. . . G. E. Ryerson and Ken Huddleston

Soil Conservation Districts are People Working Together
. . . Waters S. Davis, Jr.

Land—Key to Industrial Progress
. . . Lloyd E. Partain

Forestry as a Part of the Farm Enterprise
. . . W. S. Swingler

Teaching Basic Soil Principles Puts Conservation on the Land
. . . W. A. Mitcheltree and H. R. Slayback

Book Reviews: Soil Conservation Districts in Action, Pasture Production & Management and Soil Microbiology

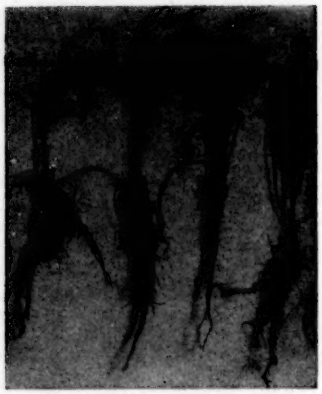
INCREASE SOIL FERTILITY

and CROP YIELDS with

FOUR LEAF

powdered Rock Phosphate

With Four Leaf Phosphate



Without Four Leaf Phosphate

The sweet clover roots shown above were from the same day's seeding and only a rod apart in the same field. Four Leaf Powdered Rock Phosphate was applied to the row in the top illustration at the time of seeding. The enormous increase in the root structure shows the greater soil improvement benefit. Top growth corresponded to root growth.

Legumes and grasses play a major part in the building and maintenance of fertile soil. And, it takes plenty of phosphorus to raise good legumes and grasses. That's why thousands of conservation-minded farmers are using Four Leaf Powdered Rock Phosphate.

The low-cost, natural finely ground rock phosphate fits well into conservation plans for permanent pastures or rotation crops. It may be used liberally and will continue to provide needed phosphorus for years. Four Leaf is ground *extra-fine* for quicker action and better distribution. It supplies vital phosphorus needed by legumes for healthy, extensive root systems.

The farmer profits in many ways. He gets MORE protein-rich feed at low cost. Better root systems break up compacted sub-soil . . . make more food available to the growing plant . . . improve drainage and leave more essential organic matter in the soil.

Phosphating with Four Leaf is a sound farming practice. It fits right in with conservation farming methods . . . promotes the healthy growth of nutritious legumes and grasses that reduce erosion and runoff to the minimum . . . improves soil structure and fertility thus preparing the land for the greater production of all crops in the rotation.

THOMSON PHOSPHATE DEPT.

INTERNATIONAL MINERALS & CHEMICAL CORPORATION

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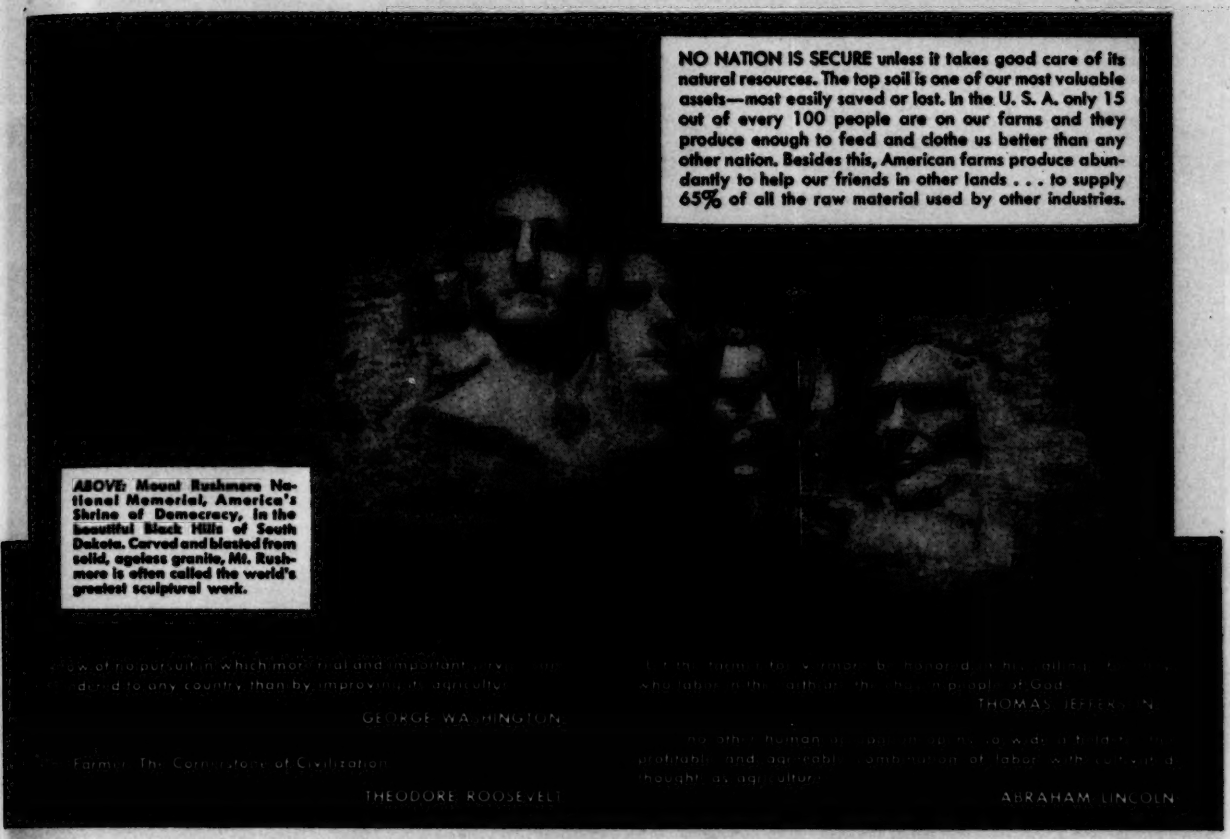
These four Farmer-Statesmen found the "Roots of Freedom" in the soil!



NO NATION IS SECURE unless it takes good care of its natural resources. The top soil is one of our most valuable assets—most easily saved or lost. In the U. S. A. only 15 out of every 100 people are on our farms and they produce enough to feed and clothe us better than any other nation. Besides this, American farms produce abundantly to help our friends in other lands . . . to supply 65% of all the raw material used by other industries.

ABOVE: Mount Rushmore National Memorial, America's Shrine of Democracy, in the beautiful Black Hills of South Dakota. Carved and blasted from solid, ageless granite, Mt. Rushmore is often called the world's greatest sculptural work.

. . . know of no pursuit in which more real and important service can be rendered to any country than by improving its agriculture.

GEORGE WASHINGTON

. . . Farmer: The Cornerstone of Civilization

THEODORE ROOSEVELT

. . . I think, from the very nature of their occupations, that those who labor in the earth are the chosen people of God.

THOMAS JEFFERSON

. . . no other human occupation opens so wide a field for the profitable and agreeable combination of labor with the cultivated thought as agriculture.

ABRAHAM LINCOLN

You can help preserve that freedom through sound soil conservation

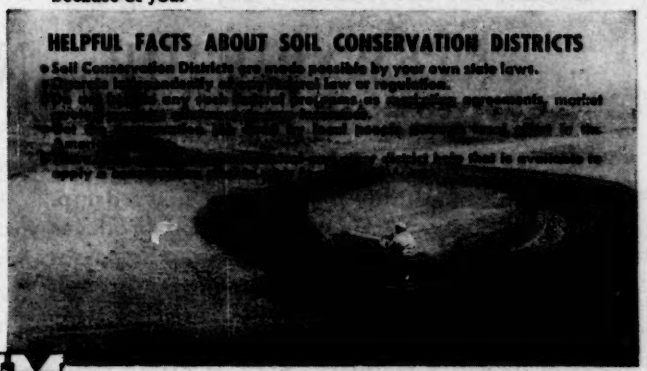
Your freedom . . . America's freedom . . . is rooted in the topsoil!

Washington knew this when he spoke out for soil conservation. Jefferson, Roosevelt and Lincoln knew it when they spoke for agriculture. Because they were farmers themselves, all four knew that hunger and poverty breed war and strife . . . that food and the products of the farm are powerful weapons for peace and freedom. They knew, too, that America's agriculture and the enterprising American farmer were, and are, keys to American greatness . . . that the industry of the soil was, after all, the basic industry of any nation.

Today, those things . . . the peace and freedom that hinge on farm production . . . are in the hands of you, the American farmer. *That* is why *soil conservation* is important both to you and to America.

Year after year more of America's future washes away—needlessly. Is anything being done about it? Yes, thousands of modern farmers like yourself are seeing the need for sound conservation practices and *are* attacking the problem. Typical are the farmers who have organized and manage 2300 non-political Soil Conservation Districts. Sure, it has cost them some money as an original investment. But ask a soil conservation man and he'll tell you that his land pays him many times over what he puts into it. Increased production pays back the principal plus increased yields. Then too, the generations of the future who will continue to live by the land, will benefit as even you do.

If you are interested in the program of Soil Conservation Districts, see your MM dealer today or write to the United States Department of Agriculture, Washington, D. C. Ask for complete information on establishing a soil conservation district in your neighborhood. You too, will find that the "Roots of Freedom" are in the topsoil . . . and they will be stronger because of you.


HELPFUL FACTS ABOUT SOIL CONSERVATION DISTRICTS
• Soil Conservation Districts are made possible by your own state laws.

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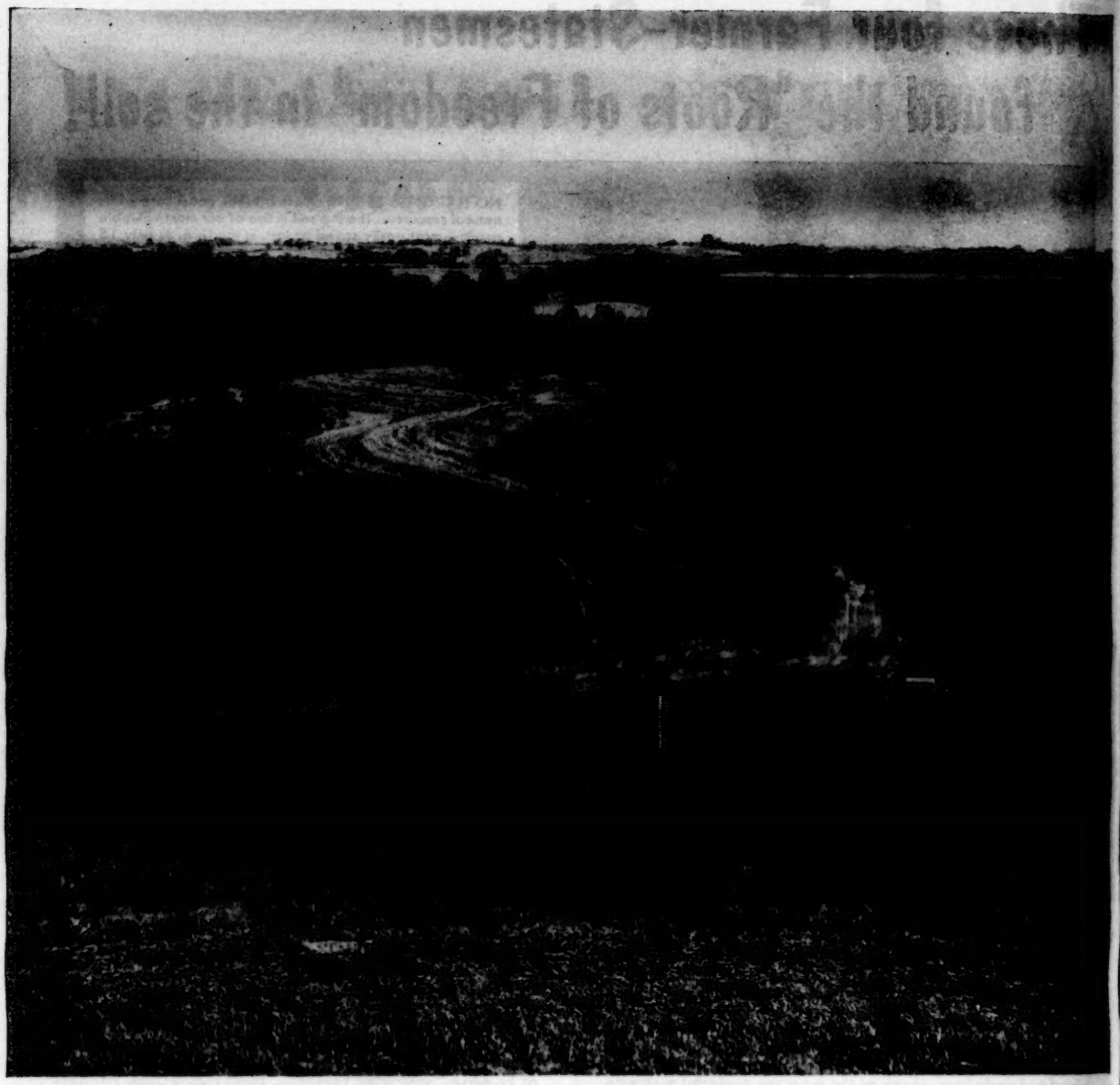

STEWARDSHIP... NOT OWNERSHIP!

No man truly owns the land he farms.

Rather, he holds that land in stewardship. If he is a good steward, his land produces for him and enriches him. In time, he passes the stewardship of this land to others through inheritance or sale.

But if his stewardship is poor, nature asserts her prior claim. Natural forces go to work to reclaim for nature what is her own. Erosion takes the top soil. Gullies make fields unworkable. Scrubby growth takes over. There is nothing left for posterity.

It is the aim of those who preach the doctrines of conservation, within a Soil Conservation District, to assure good stewardship over the land our farmers hold in trust. We who build modern farm equipment are also their disciples.

Building a better world through better farm mechanization is the business of Harry Ferguson, Inc., Detroit 32, Mich.

Copyright 1953 by Harry Ferguson, Inc.

The rain that benefits ...can also DESTROY!

LIKE most of nature's blessings, rain isn't always as beneficial as it might be. Often it destroys what it helps build . . . washes away our crops or the soil around root systems . . . starts sheet and gully erosion . . . silts our streams, blocks rivers.

Yet with proper land management, the right tools and the knowledge of experts, farmers can prevent the destroying hand of rain. It means keeping the rain up on the hills through contouring and strip cropping, planting marginal land to timber, filling in gullies, planting grassed waterways, building ponds.

It takes tools like drill planters to follow the contours, one way plows to throw the soil up the hills and build terraces to help hold the soil in place. It also means holding soil with the high stubble left by Self-Propelled combines . . . breaking up hard pan with sub-soilers and chisels so heavy rains soak in quickly.

Here at Massey-Harris there's a continuing program of improvement and design . . . a never-ending policy to develop the machines and power the farmer needs to make more profitable use of his land, more profitable use of his time.

Soil conservation is a job for everyone. For the farmer whose land is at stake, for we who build the power and machines he needs to get the job done, for those who guide and instruct the nation's 6,000,000 farmers.

Make it a Massey-Harris

North America's fastest growing full-line implement Company

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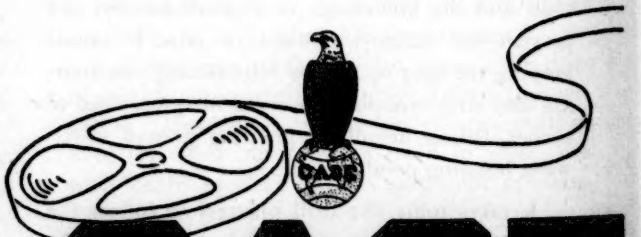
Shows You!

Here is a four-way teaching impact! New movie with companion poster, study guide, and take-home booklet tell farmers and farm youth how to make *one* acre of renovated pasture pour out all the meat, milk, wool, and cash that four unimproved acres now produce. This new quartet of Case educational materials shows how to test and treat soils—renovate old sod—establish rich new growth—how to use for immediate and long-time high income. The movie is entitled "One Equals Four," and like all Case educational movies is 16 mm., in full color and sound. Non-commercial; runs 22 minutes. Film is loaned, printed matter furnished without charge to teachers, agricultural leaders, farm and civic clubs, other responsible persons and groups. Film loans should be requested as far ahead as possible, and alternate date specified if feasible.

60 EDUCATIONAL HELPS

As its contribution to a prosperous, enduring agriculture, the Case Company has prepared some sixty educational items all free to users. These include motion pictures, sound slide films, posters, study guides, booklets, and charts on a long list of subjects on conservation and other profitable farming practices. Be sure you have the latest Case visual education materials catalog, "Visual Aids to Modern Farming." It describes each item and tells how to order. Be sure to get your catalog and all materials through your nearest Case dealer or branch house. J. I. Case Co., Racine, Wis.



CASE

Journal of SOIL AND WATER CONSERVATION

VOLUME 8
NUMBER 1

TO ADVANCE THE SCIENCE AND ART OF GOOD LAND USE

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The Cover

Industry—we are told—uses more water than any other commodity. In this connection, the total annual supply of water in any location means little. Industry is concerned with the amount available each day. The minimum supply available in the driest season sets the operating base.

—Photo U. S. Forest Service

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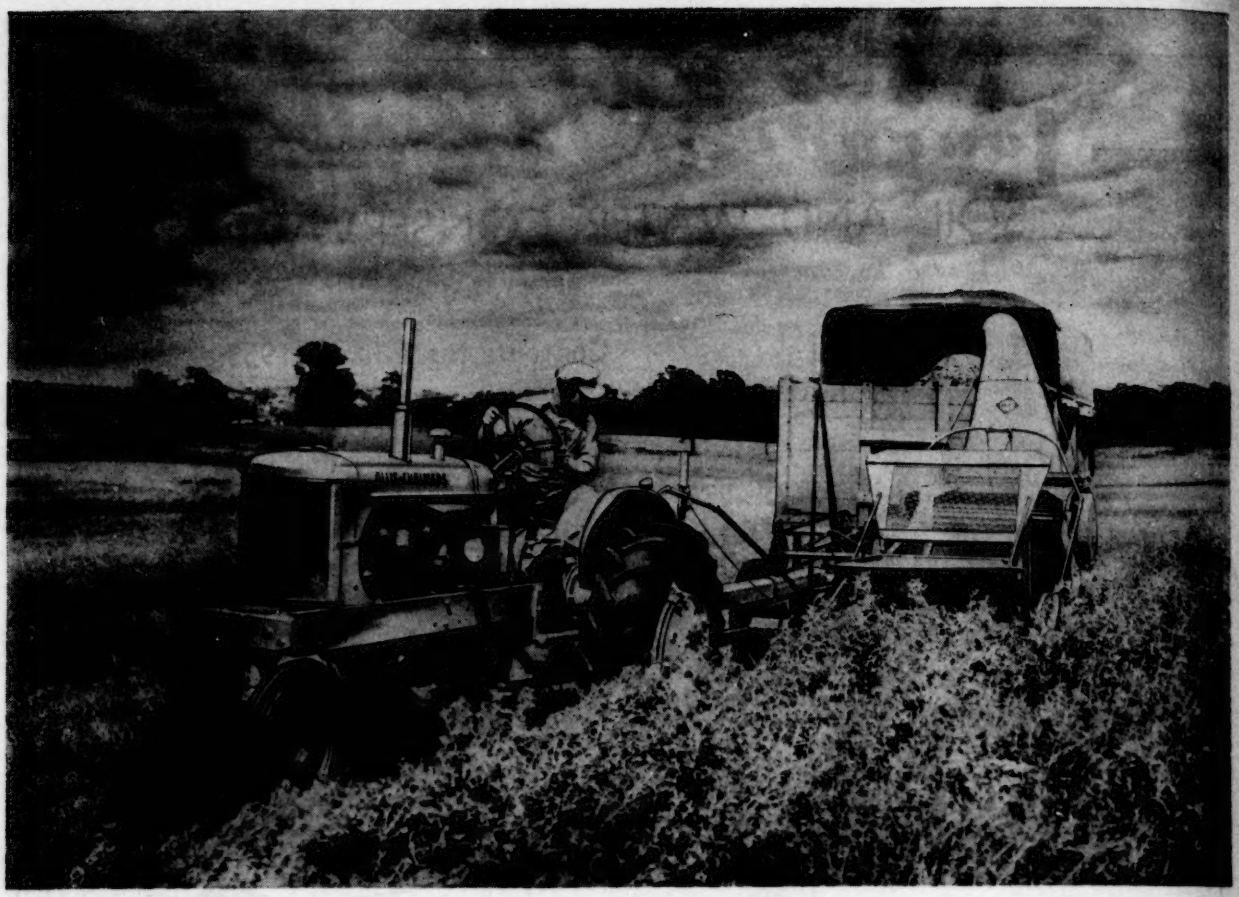

Conquering Weather Hazards in Forage Crop Farming

Power farm equipment is helping to eliminate many of the weather hazards always present at harvest time.

The Allis-Chalmers Forage Harvester provides a weather-proof system of harvesting green forages. Rain is no problem. Drouth is less serious when the farmer has a reserve store of nutritious silage when pastures dry up.

For cured hay the ROTO-BALER makes weather-resistant rolled bales that shed water like a thatched roof. Once the hay is in rolled bales, it is not damaged by moderate amounts of rain. In the western range country ranchers leave rolled bales right where they were dropped by the ROTO-BALER, and cattle feed from bale to bale.

Here is new freedom from weather hazards with equipment designed and priced for profitable ownership on the family farm.

ROTO-BALER is an Allis-Chalmers trademark.

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Turning root-bound sod with a Farmall Super M tractor and *regular* McCormick four-bottom plow. Plow Chief bottoms with replaceable Spear-Head points make plowing on the contour easy even in toughest field conditions.

523 dams in 10 acres slow water runoff and erosion

Plowing on 40-rod contours, this farmer is protecting 10 acres of rolling land with 523 runoff-slowing furrows. He is using a *regular* McCormick plow, and throwing the furrow slice uphill, to dam up heavy rains where they fall.

Contour farming conserves moisture—helps to keep runoff water from carrying away topsoil and fertility. Farming around slopes rather than over them often increases today's profits . . . safeguards future production.

Owners of *regular* McCormick tractors and equipment can easily farm on the contour, or plant, tend, and harvest strip crops. Hydraulic implement control enables them to farm across grassed waterways without stopping or even slowing down. Selective lift makes it easy to cultivate point rows.

IH dealers are conservation minded. They cooperate actively with the Dealer-District soil conservation program. They gladly advise farmers how to use McCormick equipment to carry out recommended soil conservation practices.

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International Harvester products pay for themselves in use—McCormick Farm Equipment and Farmall Tractors . . . Motor Trucks . . . Crawler Tractors and Power Units . . . Refrigerators and Freezers—General Office, Chicago 1, Illinois

The Soil Conservation Society of America Believes:

The Soil Conservation Society of America is dedicated to the promotion and advancement of renewable natural resource conservation to the end that water, soil, grass, forests, and wildlife, in abundance, may be used and enjoyed by mankind forever. The Society is founded on the knowledge and belief that these renewable resources are indispensable to the support and growth of strong, prosperous, free nations; that they are interrelated and interdependent—inseparable one from the other; and that their everlasting abundance is dependent on the development, coordination and proficient application of the several arts, sciences and professions dealing with the promotion of good resource management. Toward the early attainment of this goal the Soil Conservation Society of America pledges the direction of its energies and facilities.

The basic objectives of the Soil Conservation Society of America shall be:

1. To promote, advance, and aid continuously the several arts, sciences, and professions that have to do with the conservation of our renewable natural resources in such a manner as to encourage rapid adoption of the best possible system of land management in accordance with the capabilities of the land and with the principle of multiple use.

2. To hasten an understanding of the need for conserving our renewable natural resources to the end that it becomes an intimate part of the thinking, doing, and living of city and country folks alike.

3. To foster more intensive study of the means by which greater skill in the management of land and water can be developed and put into practice as rapidly as possible.

4. To encourage early adoption of high ethical standards on the part of all those who are professionally engaged in the furtherance of improved use of land and water.

5. To come immediately to the defense of recognized conservation agencies and organizations against unwarranted actions that adversely reflect upon their motivation.

6. To encourage early adoption of a long-range, country-wide land policy as a guide to all agencies, organizations and individuals in their renewable resource conservation activities.

7. To recognize publicly noteworthy achievements by individuals, agencies, and organizations that have assisted in the development of sound concepts and practices land and water use.

8. To provide a continuing medium for joint consideration of and undertakings in movements designed to foster more effective conservation of renewable natural resources.

9. To publish and encourage publication of constructive literature that will aid in the development of improved concepts and practices in conseravtion.

10. To encourage an enlarged research program designed to contribute toward a better understanding of the means by which more effective conservation methods can be developed and put into effect.

11. To assist in more rapid development of improved educational programs on conservation in elementary and secondary schools, in colleges and universities, and in adult education fields.

12. To aid in developing public recognition of the urgent need for a complete country-wide land inventory at the earliest possible date so that more rapid progress may be made in getting more land used in accordance with its capabilities.

13. To further as rapidly as possible the development of concepts of the importance of world-wide conservation of renewable natural resources as one of the most important steps toward permanent peace.

14. To aid in enlarging the concepts of conservation so they include not only better use of soil, water, grass, forest and wildlife resources in the economy of the world, but aesthetic and human values as well.

TO THE MEMBERS:

The statement above, at the request of the Council, was developed by a committee asked to consider the basic objective and over-all philosophy of the Society. Chairmanned by J. K. Vessey, the committee included Philip F. Allan, Lloyd E. Partain, Chester Wilson, and Ruth M. Gilmore. Although the fundamental purpose of the Society is stated in the Constitution, it was thought desirable to define more specifically the things for which we stand. What do we believe? Do you agree with the objectives stated? The Council wants a statement that represents membership thinking. Will you study the points above? Why not discuss them at a Chapter meeting? Please send Chapter and individual comments to the Executive Secretary.

Land—Key to Industrial Progress

LLOYD E. PARTAIN

The native fertility of our land enabled our first settlers to produce an excess of food which they could barter for the goods or services of a specialist—a blacksmith, doctor or minister. It was the beginning of our complete industrial society. But by the same token the loss of soil fertility can bring our industrial society to its knees. Industry can and must play a leading role in conservation and the author of this paper proposes a permanent biennial Congress on Conservation to coordinate the efforts of all interested parties—Government, agriculture, labor and industry.

LLOYD E. PARTAIN

THE NATURAL RESOURCES of our great country and their wise and intelligent use and protection form the foundation for perpetuating our strength among the nations of the world, our economic system, and our democratic form of government.

Our natural resources can be divided for all practical purposes into two broad but distinct groups: (1) renewable resources comprising soil, forests, water and all their attendant living things, and (2) non-renewable resources such as minerals, metals, petroleum and a vast number of other inorganic compounds.

I am not to any degree a specialist in either group, but have been a student of the former for many years. It is only natural and logical then that I deal for the most part with the renewable resources in my attempts to keynote this conference. I should add at the outset, too, that a third and important influence, whether we call it a separate natural resource or not, is man with all his ingenuity and labor.

The most significant fact we must keep in mind is 65 per cent of all the new wealth created in our country originates with the exploitation of renewable resources —those coming from the upper few inches of the top soil of our land. The remaining 35 per cent originates with the exploitation of non-renewable resources—mining, petroleum, etc. This partially is the reason why agriculture is the nation's largest single industry.

The most I hope to do is briefly explore some of the reasons we in industry are interesting ourselves in these matters and to ask a few questions about what lies ahead.

Many of us in industry are comparative newcomers in this field, mainly because we generally neither own nor control the source of primary production. But because we Americans have drawn on the capital resources of our land and water and other sources of supply at such a tremendous rate, all of us will do well to pause and take stock.

Nation Has Reached Maturity

Today our nation has reached maturity and we occupy the pre-eminent position of world leadership. So recently has this come about, however, that many do not yet realize it. For the first period in our history, we are faced with a deadly and implacable foe and our country's very existence may depend on our ability to survive the long haul. As one historian recently reminded us, a cold war just like the one in which we are now engaged existed between the ancient peoples of Rome and Persia for a period of 700 years. We must conserve and maintain, and where possible replenish our storehouse of natural resources so we can produce a surplus when we need it in order to keep a cold war from becoming hot and hope for world peace. This is a challenge not only to the nation, but to all its industrial and agricultural enterprises and leadership.

I am confident that industry's modern management techniques, its organizational ability and skill and re-

This paper by Lloyd E. Partain was presented as the keynote address before the Conservation Conference for Representatives of Business, Industry and Finance sponsored by the Univerity of Michigan, School of Natural Resources and Extension Service; The Michigan Chapter of the Soil Conservation Society of America; The National Association of Manufacturers; Michigan Department of Conservation. September 12-13, 1952. Mr. Partain is Sales Director of Country Gentleman and past president of the SCSA.

sourcefulness at getting a job done instead of merely talked about, will enable us to make perhaps the greatest contribution to conservation and wise use of resources of any one in the field so far—government, educational institutions, or private organizations.

Let's look a little closer at other reasons, too, why we in industry have interested ourselves in these matters. As Americans whose practicality is a national trait, we must constantly look for the profit opportunities, too. In my opinion no phase of our national effort needs the attention and support of enlightened self-interest on the part of private business more than does the conservation and wise use of soil, forests, and water. That interest converted into action is completely justified from two viewpoints: (1) government ownership of these resources, becoming more extensive every year, if extended too far, becomes dangerous; and in addition government regulation of privately owned resources, a constant threat, is even more dangerous, and (2) those of us who have not already done so must awake to the fact that rural people must farm a productive soil if they are to constitute a dynamic market for our industrial products.

The dust-storm thirties was dramatic proof that agriculture could turn into a submarginal operation that could consume little or no products of industry.

On the other hand, surely you can see what would happen to costs of industrial raw materials produced on worn out and gullied land. I don't have to remind you that renewable resources are the primary supply of two-thirds of America's industrial plants. Industries dependent on these resources include food, fats and oils, liquors, tobacco, leather goods, printing and publishing, construction, textiles and wood products.

Civilized Society a Product of Topsoil

But there is a larger reason and it is this that I want to explore more fully here. Only lately have we understood it, looking back from the vantage point of time over the road we have traveled. The reason is this: *Our entire industrial system, our whole complex economy, indeed civilized society itself, was built with the initial captial provided by the precious few inches of topsoil which covers the bountiful land we call America the Beautiful.*

Let's see why this is so. In the 250,000 years since modern man emerged on this planet, he has engaged in organized agriculture since Neolithic times, beginning perhaps 15,000 years ago. Today he occupies nearly all the 4,000,000,000 acres of arable land. What remains is desert and rock.

The last great expanse of fertile land he took over was here in the New World, most of it within the boundaries of what is now the United States. Since the end of the Pleistocene era 25,000 years ago, when the vast ice sheet covering half the North American continent receded to the Artic, Nature had been storing up its wealth in the soil and forests. Century upon century, fifty thousand growing seasons, the pine, oak, elm and gum had put out their needles and leaves to absorb the energy of the sun and air. Autumn after autumn the leaves fell silently to the ground, layer upon layer, to help manufacture the richest topsoil on the face of the globe.

Though the first settlers on the Eastern seaboard did not know it, beyond the almost impenetrable forest that came down to the water's edge there stretched a river basin covering 1,240,000 square miles, much of it flat, much of it covered with lush prairie grasses that, like the trees, had built up a fabulous topsoil.

May I pause here to repeat something the Australian Ambassador to the United States once told me. Our two countries, he said, are about the same size and occupy about the same relative latitude. But there is one thing, he went on, that you have which we lack. It is the thing that enables your country to support 150,000,000 people and lead the free world, and the lack of which limits our population to only 8,000,000 and makes us a minor force. That thing is your heartland, the Mississippi Valley. Ours is desert. Without the bounty of the Mississippi we shall always play a secondary role in world affairs.

Early Settlers Were Farmers

To go back to the settlers, where they came from nearly all land was owned by the aristocracy; farmers were little better than serfs. But here in the New World, land was for the taking, vast stretches of it, more than any one man could want or work. All one had to do was clear the virgin forest, some of its trees reaching 250 feet in height and 15 feet in diameter. But the axe and the firing with a match would do the job speedily. These land-starved people, a gnawing in their stomachs to get at the rich topsoil that lay at their feet, set to work with a fierce vigor unknown in human history.

Their efforts were repaid with the most bountiful harvests ever reaped.

Among those early settlers every man was first a farmer—not a commercial farmer as we know him today, but a man who raised the food for himself and his family. Ministers, doctors, and blacksmiths were only part-time specialists. Later, as the settlers got more land cleared, they had a surplus of food that could be bartered, and the specialist quit farming altogether to work full time at his trade, knowing that his food supply was assured. Such was the early beginning of today's complex civilization.

Soon the settlers had a surplus that could be shipped to Europe in payment for cloth, weapons and tools. There, too, this extra food began to release people from the necessity of farming. A man with a special talent went to work in a village shop. And it was the multiplication of this process which provided the labor supply without which England's industrial revolution at the beginning of the Nineteenth Century would never have flowered. As early as 1775, Ermund Burke, in his speech on Conciliation with the Colonies told Parliament: "For some time past the Old World has been fed from the New."

But let's look at the agrarian society of the United States about this time. In 1820 the nation's total population was 6,487,815. Of the total labor force, 71.8 per cent worked in agriculture while 28.2 per cent engaged in non-agricultural pursuits, which includes all the professions, business and industry.

As the settlers moved west and the more productive lands of Ohio, Indiana and Illinois began to pour out their harvests, those who could leave the farm to enter other employment had climbed by 1850 to 36.5 per cent. But it wasn't until after the Civil War, with the settlement of the prairies, that we had a food supply sufficient to feed a truly industrial society. The turning point came in 1880. The number engaged in non-agricultural pursuits was 50.6 per cent of the labor force, and those in agricultural pursuits was 49.4 per cent.

That year 1880 provides us with some revealing figures. The total population was 36,761,607. The number working in agriculture was 8,584,810. Today, 72 years later, with our population at 158,000,000, the number employed in agriculture is about the same as in 1880.

Can there be any doubt that the productive capacity of our soil makes possible our industrial labor force?

Before we mine a single cubic yard of coal or turn a lather so much as one revolution, we must first have a *man*—a certain kind of man if you please, a *fed* man. Before we could erect an industrial society we had to have a man *plus* an assured food supply.

Wages and Low Food Costs Important Factor

Let's look at two other phenomena this abundance of fertile land caused.

First, it made wages high. A man wouldn't work for another man for low wages because he could get all the land he wanted free, and could produce his own food. This free land was the origin of the highest wages for working men in the world; and the consequent highest standard of living.

Second, because food was cheap, the working man had a large portion of his high wages left over to buy industrial products. *Man spends his money first for food, the basic necessity. What remains he can spend for the products of industry. Over a long period of years in the United States, man has had to spend only 24 cents out of every dollar for food. Even now, our food bill requires only about a quarter of the dollar spent by our people. The food bill in England is more than 35 cents out of each dollar, currently exceeding 40 cents; in Italy it is 60 cents; in China and India, 90 per cent of all human energy is required to inadequately satisfy the pangs of hunger.*

Working together these two economic facts—high wages and low food costs—enabled our industrial society to pyramid upon itself; every man that entered the industrial labor force made it easier for others to enter it. Therein lies the dynamic heart of the industrial system.

So now we see where the United States got its strength to become the industrial power she is today—from the land and the food it produced.

End of a beautiful story.

Everybody lived happily ever afterward?

But wait—have we forgotten something? We have said that the wealth of the soil provided the food which fed the man who mined the coal and operated the lathe. We have said the land was the capital resource we drew on to build our industrial society.

But what about this land? It gave us food—what did we do for it?

Let's take a look.

We stripped it of its cover of trees and grass.

We put it to the plow.

We grew crop after crop after crop.

In the case of some of the thin, rocky soils of New England, we exhausted their fertility in as little as 12 years. Then we put the torch to more of the magnificent trees of the virgin forest, and moved to the new clearing. We moved westward into Ohio and later the Plains. Finally to the Pacific.

We slaughtered the game as we marched—the white-tail deer, antelope, elk, buffalo, the black bear, the beaver.

On the grassland we didn't plow, we grazed our stock. In too many instances cattle and sheep mowed the grass right to the roots.

We watched the rains come and wash the loose, naked topsoil into the creeks and rivers. The clear brooks of the primeval land which once abounded with fish flowed an ugly red or dark brown. The fish died. The river beds filled with silt. They flooded and washed away more soil. We built levees higher and higher. Our costly dams began to silt up at an alarming rate. Many had to be abandoned to no further industrial use. We watched the dry desert whirlwind fill the skies with fer-

tile soil. In the skyscrapers of New York people wrote their names in the dust that settled on the window sill. This was during the 'dirty thirties'.

Too much of this has been done to the land.

We decimated our forests. Since the settlers came the standing saw timber has been reduced by 80 per cent. Today the annual drain of saw timber exceeds growth.

In the case of tillable land, we ruined, for further practical cultivation, about a fifth of our original area. Today we are losing around 500,000 acres annually as the result of needless erosion and waterlogging. About 110,000,000 acres of cropland are being damaged at a critically rapid rate and another 120,000,000 acres at a serious rate.

When the settlers came, the United States was covered on an average with about nine inches of productive topsoil. In the intervening years, that average across the country has been reduced to about six inches.

Now and then a prophet would cry out, reminding us of the once great North African cities with the ruins of the olive presses all about. Around many of those lost cities today are the wasted, gullied lands that once produced fine wheat and were the site of great orchards.

'Where are the cities now!'—a new prophet cries—and he answers: 'They are buried 30 feet beneath the products of erosion. The archeologists are digging out the ruins of the olive presses.'

Industrial Growth a Product of Land

We shudder a moment, then quickly refer to our agricultural production charts. They show the average yields per acre going steadily up. We have too often waved the prophet away.

Let's pause here a minute; I'm coming back to this increase in yield per acre, but let's look at the whole picture in another way, in the terms of an industrial plant. Let's look at the land and its related machines—water, forests, animals—as though they were the tools in a great factory.

We have seen how this new plant was handed to us some 450 years ago and how we began to man the forges and lathes and presses and punches, which were closest at hand. As we got into production, we turned out goods and sold them for a price which covered our labor and raw materials (the seed) and enabled us to buy a few simple tools. And we had a few cents left over we called "profit."

Now as we worked this first row of gleaming machines along the Atlantic seaboard we saw another row just beyond. A few people who had made long journeys of exploration reported that we were on the edge of a factory which stretched to the West nearly three thousand miles.

There was one odd thing about this factory—it wasn't under a single ownership or single management. Each worker owned his own machine, was his own boss, produced what he wanted to, as much as he wanted to, and marketed his product in a separate transaction from that of his fellow workers. The thousands of production units made competition extremely keen. The free, open market determined the prices and the plentiful supply kept them at rock bottom.

Now as men worked their machines (the land) they began to notice signs of wear. But when they had set up their original accounting system, they hadn't included a column for plant maintenance, for the machines had been given to them free in the first place, and there were thousands, even millions, of other machines to the West merely for the taking. Under the auctioneer's hammer, they couldn't include plant maintenance in the price of their product when the market was glutted with free new machines, even better than the ones that were beginning to wear.

Many farmers brought from Europe knowledge of good conservation methods, but few could afford to put them into practice; competition forced them to accept the practices of the ignorant and the careless—which were to farm intensively, wear out the land, and move on to a new clearing.

So what the farmer called "profit" wasn't all profit—it was partly disinvestment of his capital resource.

Now I'm not opposed to use of a capital resource—as we have seen, exploitation of the land built our industrial society. But we have reached the farthest extreme of the factory. There are no free machines left; every tool is being used and they are turning at a more rapid rate than ever before. We have reached the point where we not only can disinvest no more, we must set aside something for plant maintenance; and if we are to become stronger, for capital improvement. Capital improvement in the form of conservation and wise use of our basic renewable resources—land, forests, and waters—will be an investment in the future welfare of our people. Population pressure against these resources become greater every day. There were more than 7,000 more mouths to feed at the breakfast table this morning than yesterday. We have 158 million people in the United States now and the increase is sure to continue for another quarter century. Demands of industry for the products of these resources at an increasing rate is a sure thing, too.

The last of our virgin frontiers—the Pacific Northwest— is now being drawn upon heavily and to a great extent judiciously. Alaska may offer the only untapped body of natural resources. The practicability of exploit-

ing these, in many cases, awaits development of production methods and techniques.

For the most part we can say that for the first time in our nation's history, we have populated our land. From now on we must stay where we are, make the best of what we have, and even make room for further increases in population that we are surely to have.

Difference between Fertility and Productivity

End of chapter two. Shocking it is. Yes, there is a third. It is in the process of being written. Such meetings as this and such men as you can have a profound contribution to it.

For its beginning let's go back to the fact that our machines are producing more than ever before; yield per acre is steadily going up. How do we reconcile this with the loss of so much fertility?—of course we must distinguish between fertility and productivity. Then the paradox becomes more understandable. The answer is that we are using these machines at greater than rated capacity and, unles we are very careful, they will surely wear out the sooner. It isn't that the machines (renewable natural resources) are getting better; it's that science has taught us how to get more production out of them. We must be cognizant of the fact that much of our increased yield is due to such revolutionary discoveries as hybrid corn, the improved strains of wheat and oats, scientific breeding, feeding and management of livestock, greater bearing varieties of nearly every food crop grown, and the use of commercial fertilizer, and a variety of other chemical and biological additives used to increase productivity.

So we come finally to the question, what lies ahead? The answer is plain for all to see: Conservation and man-made increased production. Plant maintenance. Fortunately the technology to do just that is being developed rapidly. Today's lack of adequate facilities for education and technical services to employ them on the land is a matter with which we should all be concerned. Here is a great opportunity for business and industry. Our role in this great work is plain. First, we must organize; second, we must develop a program, and third, we must coordinate our efforts with those of others—government, both state and Federal; educational institutions, and other private organizations.

Cordination of effort is one of the truly pressing problems in the field. At present scores of organizations and public and private agencies, each with its separate program, are attacking the problem with little knowledge of what the others are doing. *I think a step in the right direction might be a permanent Congress on Conservation to meet biennially to consider our mutual problems and to agree on a single workable program.* Soil, water, forests, and wildlife, have been called the "component parts in the machinery of nature" and are dependent one upon the other.

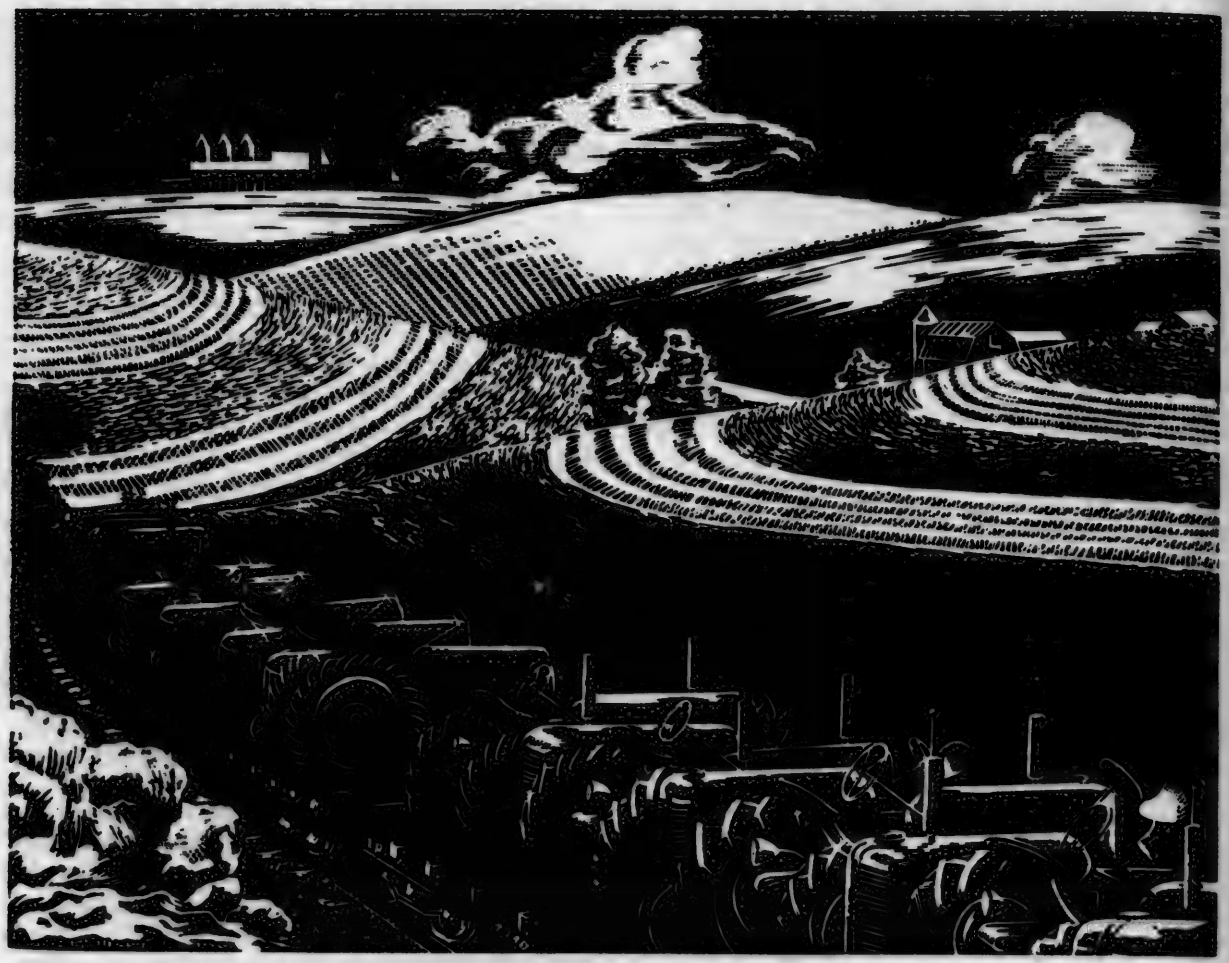
Industrial Contribution Is Far Reachng

The managerial skill of industry could contribute mightily to the coordination effort. Many examples offer definite proof that industry efforts in conservation and fuller utilization of forests, forest lands, and forest products by such corporations as the Weyerhauser Timber Company not only safeguard the perpetuation of a basic resource, but demonstrate that industry can do the job in a more satisfactory manner than can a socialistic system of government-owned and government-managed resources. Many other timber and paper companies are engaged in long-range sustained yield programs of growing more cubic measure of wood each year than they consume. Out of the four million owners of small timber holdings a majority need to practice better forest management. Many wood-using companies purchasing forest products from small holdings offer landowners the services of their trained foresters in helping develop improved forest land management plans. Such cooperative work is highly commendable.

Industrial organizations such as the Farm Equipment Institute are making soil, water, and forest conservation a major project which gets practices employed on the land at an increasing rate and enhances the market for equipment, facilities, and materials needed and used in resource conservation. Bankers and banking groups have found that a banker who gets his customers and community to adopt longtime conservation programs builds the soundest security of all. Probably the only perpetual treasury upon which we can draw is that made up of natural resource deposits. The renewable ones must be replenished and the non-renewable ones must be drawn upon judiciously.

Many of the private power companies are sponsoring conservation endeavors by community and individual action, and are finding that they pay off in at least two important ways: (1) broaden markets for energy by stabilizing incomes of individuals and (2) serve as a deterrent to the encroaching dangers of government-sponsored watershed development embodying socialization of the production and distribution of electrical energy. Numerous companies and industrial groups are, with community, state, and interstate commissions and organizations, successfully attacking stream pollution problems to find feasible ways for cleaning up streams and lakes and in the end have better quality water so badly needed by industry as well as municipalities.

(Continued on page 36)



The Farm Equipment Industry in Soil Conservation

G. E. RYERSON AND KEN HUDDLESTON

"WHAT CONTRIBUTION has the farm equipment industry made to conservation farming?"

We asked that question of a great many persons. The first said, "The farm equipment industry has provided the means to get the job done on time. It is now possible to perform farm operations at a time when they are most effective for both production and conservation.

"As an example, land now does not have to be worked in the fall and left barren throughout the winter to lighten the spring work load. The tractor does not have to be toughened for spring work, as once was the case of both horse and man. The industry has given us sufficient power to put machinery on a 24-hour shift, if necessary, and do the job right and in time."

An agricultural worker primarily interested in irrigation and drainage replied, "I believe the greatest contribution is specialized conservation machinery, such as ditching and land leveling equipment. And of course, we should not overlook the value of terracing equipment."

Other agricultural workers cited the conservation selling job that farm equipment dealers have done in their machinery demonstrations, a potent force in encouraging farmers to bring conservation into their every day operations. Those in educational work cited conservation advertising, booklets, movies, and public relations work of the industry as the greatest contributions.

The reply signified the basic interest of the person speaking. But there was unanimous agreement among all persons questioned—the farm equipment industry is one of the best allies that conservation farming has.

In many ways it is only natural that the farm equipment industry has earned such recognition. Here is a business that shipped close to two and a half billion

dollars worth of equipment in 1950—a business "in the business" of serving agriculture. The retail outlet of the industry is represented by more than 20,000 dealers with a total home-owned business investment of more than two billion dollars.

The success of the farm equipment industry depends on how well it actually serves agriculture—including the financial welfare of the American farmer. In turn, the financial welfare of the farmer depends on the productivity of his land and how well he utilizes this productivity. The industry is extremely conscious that dead acres do not support farm equipment sales.

The industry's support of the conservation movement is just good progressive business management. As the agricultural pattern of the nation is changed through further advancement of conservation farming, it is good business for the industry to be in step with such a change. As an official of one equipment company said, "We are against depletion of our soil assets as a matter of principle—and principles are daily routine with us, quite apart from the dollar sign."

Early Industry Interest

The farm equipment industry's interest in conservation farming—or progressive farming—is not new. A better way of doing things was the objective when, even in its embryonic stage, the industry was the colonial day village blacksmith who shod the wooden plow with a metal tip for better farming. And down through the years to those that followed World War I when the accepted objective of tillage and seedbed preparation was to pulverize the soil deeply, the farm equipment industry continued to provide the power and the tools needed by farmers.

The industry's first major interest in the problem of soil erosion developed in the 1920's when leading missionaries of conservation were warning the nation of the dangers of unchecked erosion. This was also an era when many leading agriculturalists advocated deep tillage, finely prepared seedbeds, dust mulches, and many other cultural practices which made land highly susceptible to erosion. It was also during this period that some soil scientists even acclaimed our soils as indestructible.

The industry was concerned with these many claims and counterclaims. Back in the horse-drawn equipment days, land destruction was somewhat limited to the amount of power a farmer had in his team of mules or horses. But with the advent of great additional power in the tractor, new problems developed. This was because the cultural practices then advocated were those adjusted to the horse-power era and not the tractor-power era. As a result, the tremendous new power in the hands of uninformed farmers did bring about considerable soil damage.

As of this period, the farm equipment industry had not done much in support of soil conservation except to show an interest in an ever changing pattern of agriculture. The industry closely followed the leadership of accepted authorities. As agricultural colleges of the South and other sections began to advocate terracing, the industry began to develop the needed tools. And there was some interest in ditching and trenching machinery. But other than these few tools in the construction field, little had been done.

Beginning in the 1930's the story began to change. The soil erosion experiment stations set up in the late 1920's began to produce results. The industry began giving more and more attention to the problems of soil erosion. Executives of farm equipment companies saw that farm after farm was being made unproductive by unchecked erosion and other bad farming practices, and farms were being abandoned. They realized that a piece of land without a farmer didn't make a customer.

The Dust Bowl Days

The sharp reality of what was happening because of erosion received nation-wide attention in the 1930's when the dust clouds swept eastward from the plains showering topsoil on our big cities and eastern seaboard. True, the drought and economic problems were in part responsible for the "dirty thirties." But the real problem was the failure to keep the soil tied down against wind erosion.

Little has been said heretofore about the activity of farm equipment companies and dealers in the old dust bowl era. But as the dust bowl began to take shape, the farm equipment industry worked literally day and night in any and all programs that offered any hope of helping farmers and ranchers counter the erosion problem.

The industry not only made available, and often free of charge, any type of machinery that could be used to check erosion, but conducted thousands of demonstrations in an effort to get farmers to use wind erosion control practices.

Different types of equipment were tried in an effort

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to check the damage by winds. A great deal of experimentation had to be done because the problem was new. But out of the many attempts there did begin to develop certain tools and practices that had a favorable effect on checking wind erosion. In general, the equipment used centered around basin listers and deep tillage tools, such as field cultivators. Subtillage plows were also developed. Deep and rough moldboard plowing was also tried. Special grass planting drills were developed to get highly erodible land back to grass. Listing was done at right angle to the general direction of the wind. In general, discing was not encouraged at that time, other than for the possibility of operating some heavy harrow plows in such a way that crop residue would be left to catch snow and rain.

Federal Action

In this same period, there was established the Soil Erosion Service which began a series of demonstration projects to acquaint farmers with erosion control practices, such as strip cropping and terracing. As conservation technology and the work of the Soil Conservation Service (replacing the Soil Erosion Service in 1935) progressed, it became obvious that if the conservation program was to be applied to the land rapidly enough, farmers would have to do more of the job themselves, and not depend on special "relief" workers to do it for them. This created a great need for the farm equipment industry either to adapt existing farm equipment to do these conservation practices or to develop new conservation equipment. The industry, after careful study, determined that much conservation work could be done with equipment already on farms.

The industry, in cooperation with Soil Conservation Service personnel and county agents, took active leadership in conservation demonstrations which many acclaim as some of the most effective field demonstrations ever held. At the same time farm equipment companies began the preparation of vast amounts of printed material and movie films describing in detail the conservation operations a farmer could do with existing equipment.

While the concept of conservation broadened to include all those practices we now place in the category of conservation farming, the industry was hard at work adapting equipment to meet the ever changing conservation requirements. Because of the greatly accelerated rate of conservation farming, the industry kept many technicians in the field to determine what effect the increased interest in conservation was having on the equipment needed by the farmer.

Soil Conservation Districts

In the meantime, most of the states had enacted soil conservation district legislation (all states have now passed such legislation), and farmers and ranchers were organizing local districts. The industry gave freely of funds and time of personnel to help the fledgling district movement grow in strength. When early soil conservation district leaders saw the necessity for a national organization, it was one of the farm equipment companies that picked up the check for the Chicago organizational meeting. Since then, along with numerous other groups, many farm equipment companies have contributed large sums annually to help the National Association of Soil Conservation Districts (a non-profit association) carry out its work of strengthening districts.

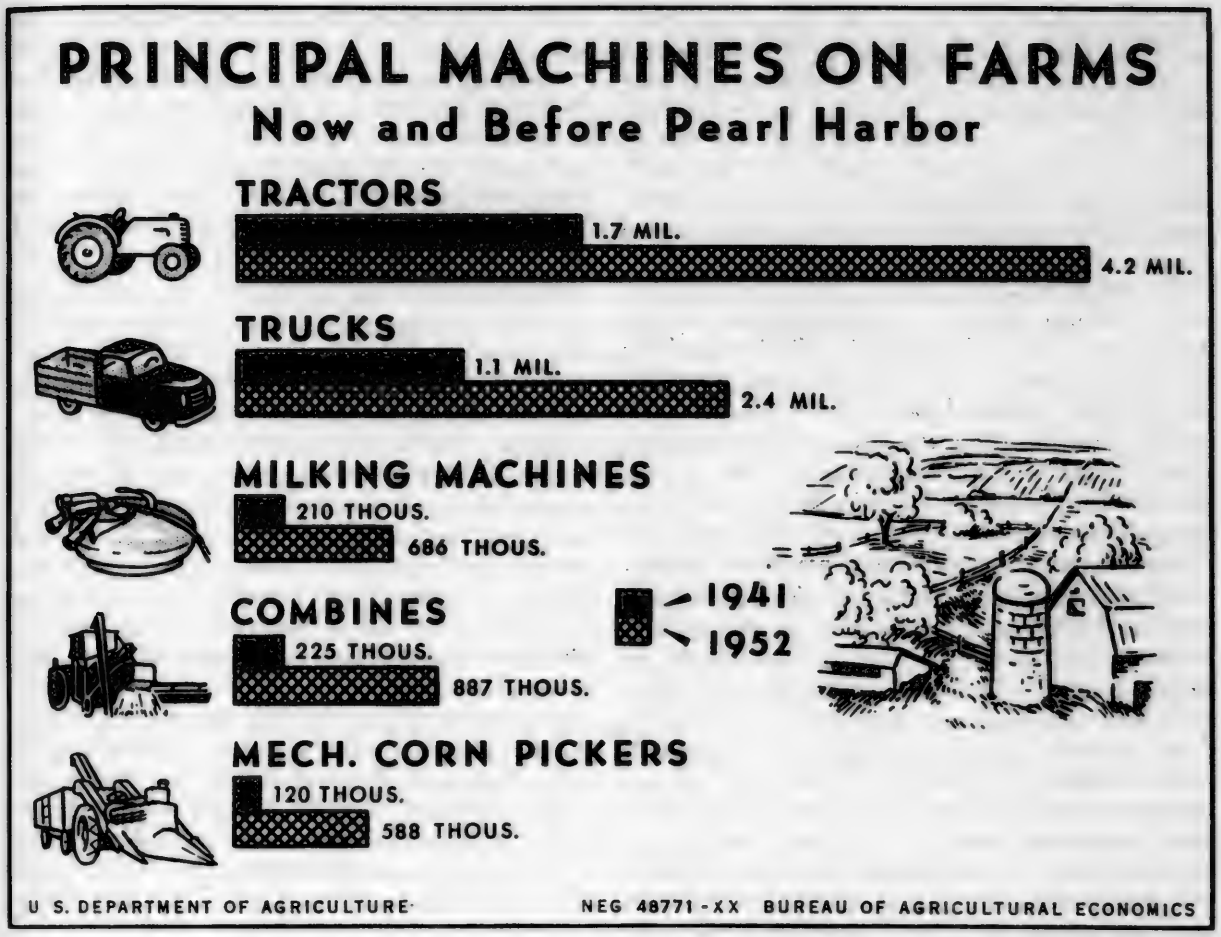
Washington Meeting

Although the industry felt that progress had been made in support of conservation, it realized that only the surface had been scratched. The industry had been working with the Soil Conservation Service and many state experiment stations on conservation research prob-association) carry out its work of strengthening districts. lems. In 1951, the annual Farm Equpiment Institute-Research conference was held at Pendleton, Oregon. The industry had provided much equipment and had given considerable time in support of the Soil Conservation Service-Oregon State research station at Pendleton.

The manufacturers realized that their support of conservation through such activities as research, advertising, promotional literature, and radio programs did not provide sufficient help toward getting the conservation job done on the land. A further analysis showed that much of the actual adaptation of farm equipment to conservation uses would have to be made at the dealer level. This could only be done if dealers became more active in local conservation activities.

The desire to bring about this closer cooperation of the Soil Conservation Service, other conservation interests, and the farm equipment industry, led the members of the Conservation Committee of the Farm Equipment Institute to go to Washington, D. C., in the later 1940's. (The Farm Equipment Institute is a non-profit trade association for the farm equipment industry, dedicated to fostering and promoting interests of American agriculture and the farm equipment industry.)

Meeting with representatives of the Soil Conservation Service, the industry committee asked the Service for cooperation in helping to acquaint farm equipment dealers with the necessity for the conservation program in their area and the specific conservation work still needed.



Dealer-District Activities

As a result of this and similar meetings a program was developed for closer cooperation between soil conservation district officials and farm equipment dealers. The program has the active support of farm equipment companies through the Farm Equipment Institute Soil and Water Conservation Committee, the National Retail Farm Equipment Association which has labeled the project "The Dealer-District Program," the Soil Conservation Society of America, the National Association of Soil Conservation Districts, and the Soil Conservation Service. Plans are under way for the Extension Services also to join the group in this activity.

This group, working together, published the booklet "The Farm Equipment Dealer and His Soil Conservation District," which is being used as a tool by the farm equipment companies to explain the district conservation program to their dealers and why they should get into the conservation picture. The industry also purchased and distributed many thousands of the Soil Conservation Society's booklet "Down the River."

The National Retail Farm Equipment Association (a dealers' association) has put a full-time employee on the payroll to conduct its Dealer-District Program. Under the auspices of state and regional dealer associations, local meetings of district officials, farm equipment dealers and others are now being held. Those attending are being encouraged to work out local programs so that farm equipment dealers are equipped to sell conservation to farmers and ranchers. More than 10,000 dealers, dealer employees, and district officials have been reached in these local meetings.

The real payoff on the Dealer-District Program, of course, is how well farm equipment dealers work with their soil conservation districts. Conservation support is not new to many of them. Progressive ones have been active in supporting local soil conservation district activities for a number of years. Many were instrumental in helping farmers and ranchers organize their soil conservation districts. Some dealers also own and operate farms and are district supervisors or directors.

From the beginning of the district movement, dealers

have been generous in loaning farm equipment to districts for conservation demonstrations, conservation field days and face liftings. Many of these dealers have been financial godfathers to new soil conservation districts when it came to finding money to cover district expenses. And as districts got on their feet financially, dealers continued to support them in such ways as advertising and bearing the costs of publishing district annual reports.

The primary objective of the Dealer-District Program is to encourage *all* farm equipment dealers to work actively with their soil conservation districts—and far beyond the cursory "Conservation is a good thing—I'm for it." This program hopes to bring about a closer working arrangement among farm equipment dealers, district officials, and conservation farmers—not to sell a specific line of equipment but rather to open an avenue for the dealer to help farmers to increase their income through the sure-fire method of conservation farming.

Although farm equipment dealers, like other business men, are highly competitive in most of their business activities, the industry does not want such rivalry to exist in conservation activities. It is proposed that, in local dealer demonstrations of the conservation uses of farm equipment, such events not end up in competitive use of machinery—but each dealer work specifically on one practice with his equipment while another dealer works on another practice. The same is true for cooperative dealer conservation exhibits at fairs. Dealers are being encouraged to get together as a local dealer group and contact supervisors of their districts and ask: "What can we do to help?"

Education

The support the farm equipment industry has given in educational and informational activities has been tremendous. Very seldom can we pick up a trade journal of a major line farm equipment company without finding soil conservation being discussed in one way or another. Soil conservation districts are receiving the same recognition.

A farmer can hardly go into a farm equipment dealer's place of business without seeing prominently displayed numerous conservation posters, charts, and pamphlets developed by the manufacturer. And this is just the beginning. In addition there are magazine articles, radio programs, television shorts, movies, and advertising.

The farm equipment industry has published vast numbers of how-to-do-it conservation bulletins. It has spent large amounts of money in producing conservation motion pictures. More conservation advertising is published annually by the farm equipment industry than by any other source.

But by no means has the industry's informational and educational material gone overboard to sell a new piece of equipment to do conservation farming; much of it has been of an institutional nature. Some of the conservation educational material has been devoted to proving that existing equipment will do the conservation job adequately and cheaply.

The industry's logic on this has been very simple. If farmers are expected to hire a contractor with heavy or expensive equipment to apply conservation practices such as the building of ponds, earth moving, and terracing, not too many are going to lay the money on the line to get the job done. Some farmers will hire the job done if they are using all of their own time to the advantage of a good hourly income. And in this case it may be the cheapest way to get the job done. But most farmers find it cheaper to do the job with their own equipment—without cash outlay. Thus by showing farmers how they can do most of the conservation job with their own equipment, more conservation is applied to the land.

One farm equipment company considered the use of existing farm equipment so important that it held nationwide training schools for its dealers, Soil Conservation Service technicians, and county agents, merely to acquaint the group with how a normal piece of equipment could be used for various conservation jobs. The cost of this training school came close to one million dollars.

Farm Equipment Design

Farmers would never have achieved the present degree of soil conservation had it not been for the farm equipment industry's development of machines particularly adapted to the requirements of conservation farming. The design engineer is constantly aware of the need to meet conservation requirements in adaptation of old equipment and the development of new machinery.

One of the first major developments was when the lowly moldboard plow took on the "new look" in conservation. The moldboards were designed to do a better job of cutting and rolling the soil more efficiently from the furrow onto the terrace ridge. Then there was a two-wheel terracer. This enabled farmers and contractors to construct and maintain terraces efficiently. Disc plows were built so that they could be used trailing the tractor or mounted directly on the tractor for such jobs as terracing.

And of course more specialized terracing equipment was developed, some using elevating graders. One piece of equipment actually threw the dirt onto the terrace

ridge. This machine constructs terraces at the rate of better than a mile a day.

Probably the industry's greatest contribution in terrace construction, however, was the alteration of all-purpose plows and discs, and development of methods so that farmers could construct and maintain terraces with equipment they would normally have. In this way, farmers were encouraged by the industry to accept terracing as a normal "good management" practice which they could do in their spare time and without great expense.

Earth Moving

In the past two decades, farmers have moved at least three billion cubic yards of farm soil for terracing, ditching, land leveling, waterway construction, and earth dams. It is obvious that without adequate power in the form of the tractor many conservation earth moving jobs would not have been done. The industry also developed such earth moving attachments for farm tractors as front-end scoops and loaders, and scrapers.

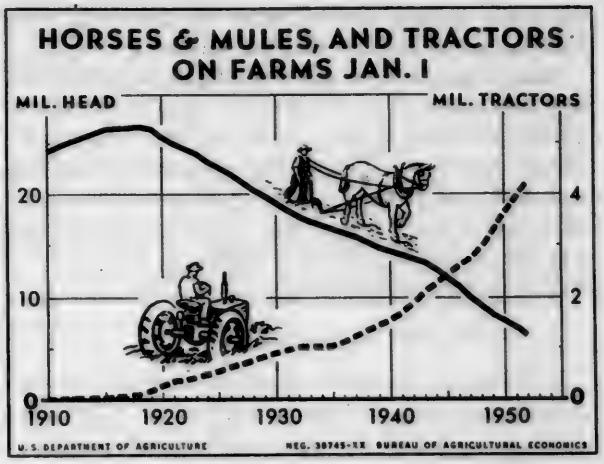
With the growth of the conservation movement, more and more farmers saw the value of changing away from the old block field system of farming to better land use with fields laid out to fit the slope of the land. This led to the rearrangement of fences on the contour and created need for more efficient post-hole digging equipment. Immediately, the industry developed post-hole digging attachments which could use the power of the tractor.

Land Clearing

With the trend to using land for its best conservation capabilities, there was also a greater need for both simple and heavy land clearing machinery. The industry is meeting this need by developing land clearing equipment specifically adapted for use with common farm equipment. In addition, the land clearing equipment developed over the past 20 years for other purposes is being fitted into the land clearing pattern to enable farmers to clear efficiently brushy and wood areas on good land. This permits a better farm conservation land use pattern. Much of the brush mowing equipment that has been developed is also very useful in conservation pasture maintenance, in removing brush which has encroached on pasture land.

Irrigation Developments

The farm equipment industry has made available many machines that increase the efficiency of both applying irrigation water and producing crops on irrigated land. One of the most spectacular is the land plane or land leveler which makes it possible to level fields for uniform application of water. In wet areas the plane helps to eliminate low water-trapping spots. The manufacturers of irrigation equipment are performing a valuable service by providing technical guidance to purchasers of irrigation systems that insures the application of a system fitted to the needs of the farmer and his land.



Hydraulic Controls

One of the most significant changes in equipment permitting more effective conservation farming was the development of hydraulic lifting power for tractors. By simple controls farmers now find it easy to lift a plow or disc, and to de-angle the disc to protect grassed waterways and other areas which they wish to keep in vegetation.

Hydraulic controls which permitted effective mounted equipment also had a secondary conservation benefit. Mounted equipment made it easier for farmers to contour farm, especially where sharply curved rows were needed. It was almost impossible for a farmer to keep on many contour lines with long, strung-out trail-type implements. Likewise, the improved flexibility of mounted equipment with hydraulic controls on the tractor made the terrace protection job much easier, especially when farmers wanted to crop the terrace area. Recent developments which permit greater flexibility in both plows and planters will aid conservation by contributing to better seed germination and plant growth.

Stubble Mulch Tillage

As interest grew in stubble mulch tillage, the industry provided greater clearance—vertical, fore, and aft—in moldboard plows and in all types of field cultivators. Without this development for areas where stubble burn-

ing was a common practice, many farmers would never have become interested in stubble mulching.

Many manufacturers have developed subsurface tillage implements, some of which replace the conventional moldboard plow. Others operate as secondary tillage implements. The efficiency and ease of operating such tools has also encouraged stubble mulching. Another tool which helped to sell farmers on this practice was the industry's special machines to beat or chop residue into shorter lengths.

Harvesters

The industry was quick to modify harvesters to meet the changing requirements established by conservation farming. Although the self-propelled combine eventually would have been accepted by farmers, its effectiveness for harvesting grain crops in strip-cropped fields contributed to its early widespread conservation use. Likewise, on terraced fields, the self-propelled harvester is very effective in that fields can be opened for harvesting on terrace lines. Similarly, many contour and strip cropped corn fields can be harvested much more efficiently with the self-propelled corn picker than with the trail type.

As an integral part of soil conservation, grassland farming was also spurred by the development of combines to handle the increased production of grass seeds. Many conservation grasses, which before the 1930's were either almost unknown or unused generally, were brought into demand by the Soil Conservation Service in cooperation with experiment stations. Manufacturers adapted the design of combines to handle seeds of varied sizes and weights. Many of the small, general purpose combines are now sufficiently flexible in operation to harvest most of the commercial grass species.

Other problems of grassland farming have also received the attention of the industry. Good hay making machinery now available enables our farmers to utilize efficiently the increased quantities of forage crops resulting from conservation farming. Improvement in self-tying balers and hay crushers are examples of this progress. Increased acreages of forage crops can be harvested with less labor and with less likelihood of weather losses.

Seeding

Seeding equipment has also had its share of design attention. As an example, the industry has made many modifications in furrow openers of drills to make equipment more adaptable for seeding through stubble. Grass seeding equipment has been developed which makes it possible for expensive seeds to be placed in the ground for better germination and plant growth. This provides greater savings to farmers with less waste of seed. The availability of efficient seeding equipment has been responsible for greater conservation grassland farming in many areas.

Research

All farm equipment manufacturers are extremely conscious of the changes in the requirements for farm machinery as brought about by conservation farming. Considerable research is carried on by individual manufacturers to meet these needs. All such research is done in closest cooperation with state and federal research institutions.

Research is still being carried on to determine the methods by which terracing can be effectively done with moldboard plows, one-way discs, and other conventional tillage equipment. There is also research to determine how row crops can be grown more profitably with better control of erosion. Similar research is being conducted on stubble mulch problems. The industry's primary interest in these studies is to develop machines which will do the conservation job.

Manufacturers are constantly testing their machines to make sure that the characteristics in existing equipment conform with the requirements presented by conservation farming. This work is valuable not only to pave the way for future equipment developments, but also discloses many new applications for older conventional machines.

Highlights

These are but a few of the highlights of the work of the farm equipment industry in soil conservation. And as numerous representatives have said on many occasions, "It's just the beginning."

The industry has seen what soil and water conservation can do for the farmer, the community, and the nation. And as one equipment company official said recently at a Chamber of Commerce meeting:

"You are naturally interested in seeing some new industries in your community, but I wonder if these 'acres of diamonds' you are seeking aren't already in your backyard in the farmland surrounding your city. I wonder if the soil conservation program I've told you about isn't the tool to help you share in this rich field of diamonds, and will bring you more prosperity than any new industry."

The entire farm equipment industry shares this view and will continue to support soil and water conservation as one of the greatest technological advancements of the twentieth century.

Rock Phosphate For Direct Application—A Natural in Soil Conservation Work Plans

A. L. LANG

Rock phosphate may be the only economical and practical source of phosphorus for worn out, impoverished, acid subsurface layers of many soils. Good soils are deep soils. Successful conservation cannot be founded on shallow impoverished land. While very beneficial as a phosphorus amendment to many surface soils, rock phosphate may be doubly so in the more acid subsurface layer. In this area the phosphorus of rock phosphate will become quickly available to penetrating roots of plants, yet the mass of the phosphorus so applied will not become indefinitely fixed as is generally the fate of that in the more soluble phosphorus carriers.

"THE PHOSPHORUS CONTENT of our soils following generations of cultivation has greatly diminished. It needs replenishing." These are the words of the late President Franklin D. Roosevelt in a special message to congress on phosphate. This interest of Government in the phosphorus problem of the United States is indicative of the fact that if industry and the individual land operator do not solve the problem the Government will have to do it.

Rock phosphate is the basic source of virtually all of the fertilizer phosphorus in the United States. It is found extensively in Tennessee, Florida, Idaho, Wyoming and Utah, with by far the most extensive deposits in the North Western area. The greatest mining operations are at present in Florida. Superphosphate, the most widely used fertilizer in the United States, is made by the rather simple process of mixing rock prosphate with sulfuric acid. Roughly mixing one ton of rock phosphate with one ton of sulfuric acid makes two tons of regular superphosphate, the latter containing per ton only half of the phosphorus in the original ton of rock phosphate. The process is carried on to make the phosphorus of the rock phosphate more available to plants. Obviously if the soils are crops to which the rock phosphate is applied can accomplish the same result then rock phosphate can be a more economical source of phosphorus than superphosphate. Voluminous research findings are evidence to the fact that the phosphorus of rock phosphate is made quickly available to plants in acid solutions are acid soils. Until extensively limed most of the surface soils of the humid regions of the United States are acid with virtually all of the subsurface layers very acid and remaining so even after years of extensive surface liming. Logically then the below plow layer acid soils of the humid areas should serve as a huge acidulating factory for releasing the phosphorus from rock phosphate. This approach to the phosphate problem should open up a great new field for the expanded use of rock phosphate. Furthermore it would serve as a great phosphorus depository during times of peace and prosperity which could be drawn on during times of war and famine. One well known agronomist has said, "If we don't use rock phosphate to replenish the phosphorus in the acid sub soils how are we going to get the job done?"

A further attraction for this approach is the possibility of bringing about greater root growth in the sub layers of soil. Such a reaction can have far reaching results. Greater accumulation of roots in the subsurface area should lead to more organic matter, better water and air penetration, better drainage and greater overall production, especially in adverse seasons. With the improvement of subsurface drainage the problem of keeping surface soils in place should be less difficult.

Fits Well Into Conservation Planning

Striking a balance in land use between tilled and non-tilled crops that will provide for maximum water control and reasonable economy of production is an important step in a good soil conservation plan. Annual to permanent meadows is a phase of the non-tilled cropping. Such meadows usually contain a high percentage of legumes for nitrogen economy reasons. Establishing and maintaining the meadow is often the most expensive and difficult job connected with the plan. Rock phosphate fits well into this scheme. Legumes are known to be strong feeders on the phosphorus of rock phosphate. That makes its use practical. When used in connection with legumes the phosphorus of the rock is also made more readily available to following crops. Because of its low cost and long lasting residual effects rock phosphate can be applied for meadows at relatively high

A. L. Lang is professor of soil fertility, University of Illinois, Department of Agronomy, with headquarters at Urbana. He has spent more than thirty years of his life with the Illinois system of soil experiment fields and with the farmers of that state where more experiments and more use of rock phosphate has been made than any other place in the world. Professor Lang has written many papers and articles on the subject of rock phosphate.

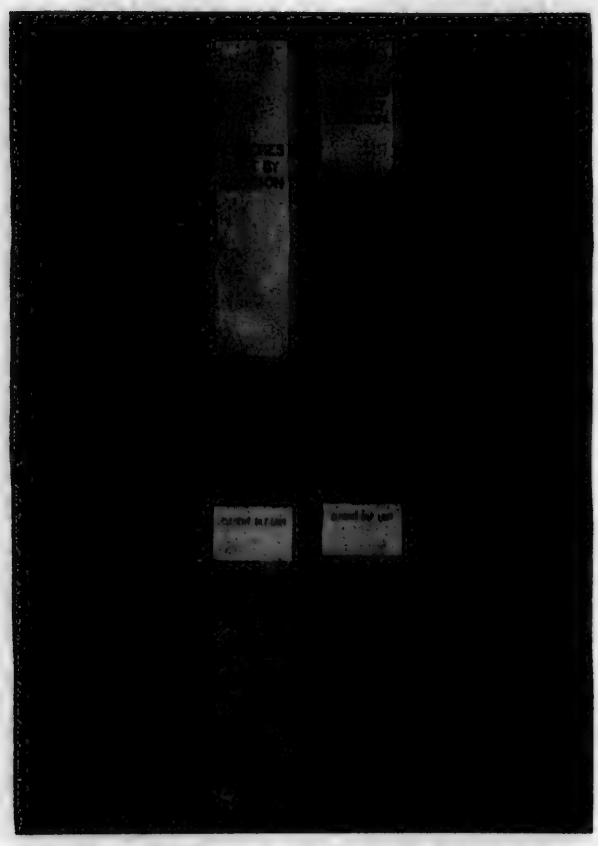


Figure 1. Elizabethtown Soil Experiment field. Profile on left from untreated plot. Profile on right from plot treated with manure, limestone and rock phosphate.

rates per acre (1000 to 1500 pounds) before seeding where it can be worked thoroughly and deeply into the soil. There are obvious advantages in applying phosphorus that way. Labor and machinery are saved. A better and deeper distribution of the rooting system is encouraged over a longer period of years than will be true where annual applications are made to the surface or where phosphorus from soluble fertilizers is quickly and indefinitely fixed. Deep rooting makes for more drought resistance in the meadow and encourages more water absorption. Greater vegetative growth, less water run off add up to protection from soil loss by sheet erosion and gullying.

Soil Losses Reduced

When used as the only source of phosphorus in a system of soil management aimed at restoration of production on worn out hill lands of southern Illinois rock phosphate aided in retaining elevent inches more surface soil on land with ten per cent slope than was saved on untreated land of the same area. On this land at the Elizabethtown soil experiment field in Hardin county with reddish-yellow silt loam, slowly to permeable subsoil eight systems of soil management were established in 1917. They included comparative treatments in livestock and grain systems of farming. In the livestock systems all crops were removed and equal amounts of manure returned in their place. In the grain systems all crop residues were returned to the land and legumes were used as a supplementary source of nitrogen and organic matter. A four year cropping system, corn, oats, meadow, wheat (catch crop legume) was used. Erosion and gullying has made the untreated area of this experiment almost unfarmable even with the painstaking experimental hand technique. Fully treated plots however, including limestone, rock phosphate have built up and maintained good average crop yields with little or no observable erosion or gullying. In 1933, seventeen years after the treatments in this experiment were started, profile studies were made on two plots. The profiles reflected a marked difference in surface soil losses. An untreated plot had lost 20 inches of surface soil. A nearby plot, which in addition to a good cropping system had been treated with manure, limestone and rock phosphate showed a loss of only nine inches of surface. This saving of 11 inches of surface soil had been brought about on land with ten per cent slope. Figure 1. These data have been previously reported and the profile illustrated by Van Doren and Bauer, Soil Science Society of America proceedings Vol. 11, 1946, page 543. Not only have soil losses and gullying been retarded on this land but crop yields have been maintained at a relative high level over a long period of years. In table one are given the yields of this experiment for the last four year period 1948-51. Corn yields have been maintained at a level more than 50 per cent above the average for the county. Oat and wheat yields are double the county average. In the livestock system rock phosphate has increased the average annual income by $6.00 an acre a year and in the grain system by $15.00. The latter figure gives a return of more than $6.00 per dollar invested in the rock phosphate. Potassium added to the system has further enhanced the value of the phosphate treatment.

A Natural on Livestock Farms

Where annual, biannual or permanent meadows make up an important part of the cropping system of a farm it is good economy to use the meadow through livestock. On a livestock farm rock phosphate is a natural. It makes manure a better balanced and more productive fertilizer. A 10-10-10 is often spoken of as a good and balanced fertilizer. The numbers indicate the percentage of nitrogen, phosphoric acid and potash, respectively, in the fertilizer. As compared to 10-10-10 a ton

of manure analysis 10-5-10 showing a need for balance in its phosphorous content. Manure at ten tons an acre (the average four year application) furnishes 20 pounds of the element phosphorous, an amount less than that required to produce a 100 bushel crop of corn. Along with the manure a thousand pound acre application of rock phosphate (32 percent phosphoric acid equivalent) will replace the phosphorous removed by grain and hay in a five year rotation over a period of ten years at maximum production. That is equal to 200 bushels of corn, 100 bushels of wheat, 160 bushels of oats, 100 bushels of soybeans and six tons of alfalfa hay.

Elizabethtown Soil Experiment Field
Table 1. Average annual acre crop yields, 1948-51

Treatments	Corn	Winter oats	Hay	Wheat	All crops Current value	Index
O	13	7	0.0	6	$9.04	100
M	40	31	0.3	19	30.49	337
ML	64	51	1.2	29	51.54	570
MLP	64	56	1.7	34	57.55	637
O	13	7	0.0	6	9.04	100
R	15	10	0.1	7	11.48	127
RL	42	25	0.6	19	31.07	344
RLP	54	38	1.3	28	46.22	511
RLPK	66	42	1.6	34	54.97	608
County average (1947-50)	43	15	1.28	17		

Returns from rock phosphate when used in addition to manure and limestone have been accurately checked over a long period of years at two Illinois experiment fields, (Elizabethtown and Joliet). During the last four year period there has been an annual return per acre a year of $6.00 and $10.00 respectively for the phosphate.

Forage Crops Respond Well to Rock Phosphate

Many states have shown that on at least a part of their soils, legumes and legume mixtures respond well to applications of rock phosphate. Some of the states reporting data on this subject are Missouri, Oklahoma, Arkansas, Kansas, Kentucky, Indiana, Alabama and Illinois. Workers in many other states have expressed the opinion that rock phosphate should have a place in their pasture and soil conservation programs.

In Illinois where rock phosphate has been used regularly in the experimental work there are numerous opportunities to measure the response of forage crops to this source of phosphorus. A few of these will be discussed. At Urbana a permanent pasture meadow was established in 1935 and allowed to stand for ten years. During this time rock and super phosphate were applied in equal money valued to limed and unlimed areas. Each carrier was applied in the spring as a top dressing on the meadow. Rock phosphate (30 per cent) was applied at the rate of 300 pounds an acre a year and 0-20-0 was applied at the annual rate of 150 pounds an acre. The applications were continued annually until 1000 pounds of super and 2000 pounds of rock had been applied. At the end of the ten years there was no significant difference in the measured response of the two phosphates. However, there was three times as much phosphorus remaining in the soil for future use on the rock treated plots as there was on the super treated plots. The residual effect of this phosphorus showed strikingly in 1952, nine years later when the area was again seeded to a pasture mixture. The results of this work are shown in Table 2.

Figure 2. Treated and untreated pasture grass plots, Elizabethtown Soil Experiment field.

Table 2. Pasture fertility, Mumford plots, Urbana, 1935-44

Treatments	Oven dry weights in pounds an acre					
	UNLIMED LAND			LIMED LAND		
	Monthly[1] clipping	Percent nitrogen	Mature hay	Monthly[1] clipping	Percent nitrogen	Mature hay
No phosphate	1272	2.36	1489	1699	2.58	1714
Rock phosphate	1752	2.47	1717	2041	2.70	1987
Superphosphate	1711	2.52	1778	1064	2.68	2009

[1]Average annual yields made from five monthly clippings May, June, July, August, September.

Five different pasture mixtures being studied at the Elizabethtown station further demonstrate the contribution that rock phosphate can make to the meadow crops, Table 3. In this experiment rock phosphate has been as effective as superphosphate and at some saving in cost. Figure 2 shows an untreated plot of this experiment along with one treated with rock phosphate, limestone nitrogen and potash. The treated plot has an excellent

Figure 3. Left. Limestone and potash treatment, University of Illinois Soil Experiment fields. Right. Limestone, residual rock phosphate and potash, University of Illinois Soil Experiment fields.

stand and growth of alfalfa brome while the untreated plot has only wild brome sedge growing.

Table 3. Effect of soil treatment on five pasture mixtures, Elizabethtown soil experiment field

Treatment[1]	Average annual yields in air dry pounds per acre from five mixtures
None	750
Limestone	1170
Lime-rock phosphate	2390
Lime-rock-nitrogen	2850
Lime-rock-nitrogen-potash	3390
Lime-superphosphate-nitrogen-potash	3430

[1]3250 pounds of rock phosphate and 2400 pounds of superphosphate have been applied to their respective plots in this experiment. They are residual after having been applied for previous crops. 6000 pounds of limestone has been applied to each lime plot.

Residual Response Impressive

Forage crops in regular cropping systems on three outlying experiment fields located at Ewing, Newton and Oblong show residual response after 25 years of cropping without phosphate fertilization. On these fields four tons of rock phosphate were applied per acre during a period from 1910 to 1924. From 1924 to the present no further applications have been made. The average increase of the forage crops on these fields due to the residual phosphate was 1566 pounds an acre. This response was in addition to that for limestone potash. The total application of the phosphate for the entire period of 42 years would amount to 200 pounds an acre a year. The data are given in Table 4.

Further residual effects of rock phosphate has been established on plots at Urbana where 1500 pounds of rock phosphate was applied per acre in 1935 and crop for 15 years to 1949 without additional applications. These results are shown graphically in figure 5. At the end of the 15-year period the rock phosphate treatment had returned at current prices $129.67 per acre in crop response over limestone. This was $8.65 per dollar invested. In the same experiment where an equal amount of money was invested in superphosphate $73.54 worth of crop increases were produced or a return of $4.90 per dollar invested was returned.

Not a Substitute But an Addition

Rock phosphate may have a contribution to make even in soil management programs where soluble phosphates are recommended to supply most or all of the crop requirements. Without thorough investigation it should not be condemned on the fact that it may not be able to substitute for that which is already being used. As already suggested it may be used to add to the subsurface requirements or supplies. By partially replacing a more costly product perhaps more money would be available for other badly needed ingredients as nitrogen or potash.

In Illinois rock phosphate has been universally recom-

Table 4. Residual effect of rock phosphate on forage crops, Ewing, Newton, Oblong

Four year average 1948-51

Field	Residues limestone Rock phosphate Potash (lbs.)[1]	Residues Limestone Potash (lbs.)[1]	Increase for Rock phosphate (lbs.)[1]
Ewing	3200	1940	1260
Newton	4560	2400	2160
Oblong	4640	3360	1280
Average (one cutting)	4133	2566	1567

[1]Air dry pounds an acre.

Leaders in Soil and Water Conservation Honored

The following ten individuals were elected as Fellow Members of the Soil Conservation Society of America and so honored at the 1952 Annual Meeting held in Buffalo, New York. This recognition goes to members professionally engaged in practicing, investigating or teaching soil and water conservation.

Arthur B. Beaumont. State conservationist for Massachusetts, with the Soil Conservation Service since 1945 . . . 33 years in that state as teacher of agronomy and allied subjects . . . Ph.D. from Cornell, traveled extensively in the South (where born) and acquainted with erosion at its worst . . . editor of the "SOIL AUGUR" which he founded in 1940 . . . widely traveled in the United States and Europe studying soils.

Edward H. Graham. Charter member of the SCSA and first chairman of the Washington, D. C. Chapter No. 1, headed the Editorial Board when the JOURNAL was first established . . . biologist, traveled extensively and has had wide teaching experience . . . now assistant chief of the Soil Conservation Service . . . author of *"Natural Principles of Land Use"* and co-author of *"The Land Renewed,"* also numerous other papers and reports. He is a native of New Brighton, Pa., B.S. and Ph.D. degrees from the University of Pittsburgh.

Walter C. Gumbel. Editor, Journal of Soil and Water Conservation, author of many articles on conservation, originated newspaper column *"Manhandled Soil"* while member of extension staff, West Virginia University . . . later with Soil Conservation Service in Pennsylvania, then accepted post as conservationist for the Monongahela Power Company in West Virginia, started as county agricultural agent with major accomplishments in the field of land use and resource development.

John Lamb, Jr. Research in erosion control, cover, soil structure and allied activities hold his major interest . . . former director of research for the Soil Conservation Service in New York . . . has done many studies in the value of time in farming operations, promotion of land management and treatment and worked hard to establish supplemental irrigation in northeast as a routine practice . . . has been prominent in the organization of research programs for the Soil Conservation Service.

Arthur C. M'Intyre. A leader in forest management, has published many articles in this fields, also related subjects . . . Michigan State College graduate, research forester for the Pennsylvania Agricultural Experiment Station . . . lead movement for improvement of farm woodlands including the greater use of wood chips in farming operations . . . editor of "PENNSYLVANIA CONSERVATION" . . . is active in SCSA work at all levels.

Edward N. Munns. A prominent leader in the field of water conservation and management . . . retired from U. S. Forest Service after distinguishing work in fuel, timber, water problems . . . native of St. Louis, M.S. degree University of Michigan . . . past chairman Washington, D. C. chapter of the SCSA, fellow Society of American Foresters, has authored many papers, served dynamically with numerous public and semi-public conservation groups.

Austin L. Patrick. One of the organizers of SCSA, led work on constitution and by-laws, served many years in official capacities and active in development of new chapters across the nation . . . native of Pennsylvania, former professor of soil technology at Penn State, later assistant chief and now regional director of the Soil Conservation Service for the northeast region . . . Dr. Patrick is the author of many articles; also an authority on land use.

Fred J. Sykes. An outstanding Kansas wheat farmer before getting his B.S. degree in agriculture. He turned to farming again and later became a county agricultural agent, now state conservationist for Kansas . . . an outstanding characteristic is his ability to work with and organize people . . . pioneered development of SCSA chapters in Kansas, has been a diligent worker in countless groups . . . was active in helping to control "Black Blizzards."

Alvin C. Watson. Assistant regional director of the Soil Conservation Service in the Northeastern region with headquarters at Upper Darby, Pa. . . . native of Pennsylvania, B.S. degree from Penn State . . . wide experience in teaching of science, mathematics and agriculture, also in farm management work . . . past national secretary SCSA, Editor of "NEWS NOTES AND ACTIVITIES" for three years.

Fred A. Wirt. Prominent J. I. Case Company agricultural engineer and teacher, pioneered in engineering suitable machinery for building soil conservation terraces in southern states . . . member of the SCSA Council, chairman of the society's first finance committee. Has done an outstanding job in developing visual aids for teaching conservation. Past president American Society of Agricultural Engineers . . . native of Nebraska and holds a B.S. degree in civil engineering.

Honorary Membership in the Soil Conservation Society of America—for outstanding contributions to the field of soil and water conservation—was granted to the five individuals shown below.

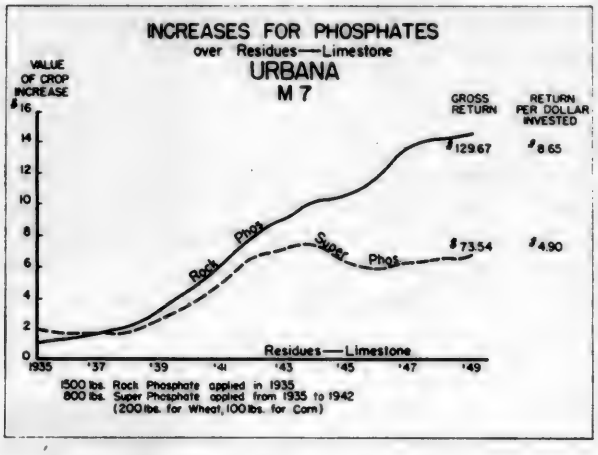
A. G. Brown. Nationally-known banker formerly associated with the Federal Land Bank and other public institutions, has done much through addresses and articles to stimulate interest of financial groups and men in conservation . . . as head of the American Bankers' Association's agricultural program, sees to it that annual meetings devote time to soil and water conservation and other agricultural topics . . . helped prepare handbook "WHAT BANKERS CAN DO ABOUT CONSERVATION."

Waters S. Davis, Jr. President of National Association of Soil Conservation Districts, one of the most active volunteers in the field of soil and water conservation . . . native of Texas, educated in the east . . . became interested in farming and conservation practices when he settled his father's estate, knew there was a job to do in keeping things from "going to pot." . . . chairman of his local soil conservation district board of supervisors . . . has led programs for land use, drainage improvement, forest management and others . . . creator and first editor of "TEXAS TOPSOIL."

Walter R. Humphrey. Became a conservationist as newspaper editor while watching progress of a reclamation project . . . promoted a conservation awards program in Texas for farm people who practice conservation measures and for groups having similar interests . . . is in great demand as a public speaker . . . has been honored by American Forestry Association, press associations, active in church and civic affairs. He is a native of Missouri and a graduate of the University of Colorado.

J. E. Noll. Helped to finance and establish the federal and state experimental farm near his home in Bethany, Mo., as first definite contribution to conservation work . . . has been key man in the organization of soil conservation districts, helps to promote conservation field days, plowing matches and many other competitive activities . . . is a prominent land owner, business man and banker and believes sincerely in an improved agriculture for future Americans.

Alfred M. O'Neal. Started as soil surveyor in Alabama after some industrial experience, went into field of soil science, worked out the modern color standards charts . . . has devoted much time to studies of soil permeability, developed soil "key" which is accepted as outstanding contribution to conservation progress in this generation . . . past president of Soil Science Society of America, and has traveled extensively in the United States.



mended for almost a half century as an important part in a definite soil management program. This management program has as a goal one single objective that of soil fertility restoration and preservation. To accomplish this it has seemed desirable to keep the system simple, economical and long lasting. Rock phosphate lends itself well to that kind of thinking especially when the system is directed towards the welfare of the soil regardless of its use. Because of this rock phosphate supplies most of the phosphorus requirements and other materials are looked upon as supplementary and contributory to it. If so desired the reverse could be true.

Fundamentals

Contrary to the common belief rock phosphate under favorable conditions will give immediate response not only to legume crops but to most of the common agricultural grain and grass crops. In a recently established experiment at the Urbana station corn was increased 18 bushels an acre by an application of 1600 pounds of rock phosphate applied to soybeans the previous year. This same application has continued to give similar responses for the past five years. The same kinds of response have been recorded for wheat oats and pasture grasses.

There are three basic principles involved in the securing of satisfactory results with rock phosphate. These hold for most any single plant nutrient carrier. The soil must be physically fit, but for phosphorus chemically balanced and relatively heavy initial applications must be made.

Generally speaking, in Illinois where rock phosphate has been used so successfully, its use has been recommended in such a way as to create favorable factors. Physical fitness, nitrogen and moisture are the common limiting elements in Illinois grain production. Heavy applications of rock phosphate have been recommended on phosphate deficient soils to grow legume crops which in turn supplied nitrogen, improved the physical structure and moisture supplying power of the soil thus accounting for the major success and satisfactory results with rock phosphate. Largely because rock phosphate has been used in this approach to improved crop production it, along with the Illinois system of permanent soil fertility, has often been dubbed as too slow, not by farmers but by those who have had something to offer in competition. Such criticism has led to unwarranted beliefs by those not familiar with all the facts. Rock phosphate has no stimulating effect nor does it supply any plant foods other than calcium and phosphorus. This fact has often led to misinterpretations of data. Soluble fertilizers often act as stimulants chemically, biologically or physically. Where this happens, responses are not necessarily due entirely to the nutrient or nutrients supplied by the fertilizer. Where such a stimulation occurs rock phosphate is not likely to show in a favorable light until the same effect is created by some means. Proper balance of other required nutrient elements is more often than not the answer to the greater part of the stimulating effects created by single or mixed soluble fertilizers not in themselves always so balanced.

The relatively heavy applications of rock phosphate (1000 to 1500 pounds an acre) recommended and used in Illinois are fundamental to its economical use and functioning. This is true irrespective of the fact that smaller applications might give equally as good first crop increases. Some soils prevent quick breakdown of the unavailable forms and thus heavy applications assure adequate available phosphorus for the first crop. Once a heavy application is made, soil fertility restoration and preservation is well on its way, previously cropped out phosphorus has been restored and a sufficient supply is available for future use. It is wise to build up a philosophy and practice of heavy applications. Then, during times of prosperity when money is freely spent for fertilizers, soils are more likely to be provided with sufficient nutrients to last during periods of recession or emergency. Rock phosphate fits into such a philosophy because relatively heavy applications can be made without too large an outlay in initial cost. Furthermore, quantity operations affect economies in freight, spreading, storing and timing of application. Heavy applications of rock phosphate can be made anytime of the year when there is a place on the farm to spread it and seasonal labor peaks are not hindering.

Forestry as a Part of the Farm Enterprise

W. S. SWINGLER

Forestry on the farm is now big business. Ten years ago farm forest products were valued at around 100 millions dollars yearly. There has been a seven-fold increase until now farm forest products are worth nearly 700 million dollars each year. A great variety of products is represented. Lumber for use on the farm and for sale, fence posts, railroad ties, pulpwood, poles and piling, and veneer bolts are in demand. In particular localities, bean poles, tobacco sticks, hop poles, tobacco wood, Christmas trees, and the like are profitable products. A complete new source of farm income has developed rapidly in the past decade.

IN 1940 OVER 90 per cent of all the lumber produced in this country was used in our war effort. The single fact that about one-fourth of the nation's lumber and other forest products come from farm woodlands makes forestry on the farm a significant enterprise. A profitable one, too. For example, over 500 million posts are needed annually to maintain and build our fences. Here again the farm woodland, as a ready and convenient source of supply, looms important. Farmers already are producing almost half the number of posts used each year.

In an age of metal, machines, and television, not to mention the atomic bomb, modern man tends to forget his dependence on his age-old companion, wood.

Let us go back ten years and review some startling facts, facts which have been dimmed in the blinding rays of atomic development and all its attendant possibilities. In 1942 over 90 per cent of all the lumber produced in this country was used in our war effort. Eighty-five per cent of all the rayon used in parachutes was made from wood cellulose, only 15 per cent from cotton linters. One average size pine tree, insignificant alone, furnished enough cellulose to make the powder for 7,500 rifle cartridges. Enough lumber to build about 20 five-room dwellings—300,000 board feet—was used to floor the deck of one battleship. And here is a statistic we can hardly forget—in the peak years of the war we used 25 per cent more wood than steel on a tonnage basis.

These may be old statistics to many of you. Some of you, however, will never forget the great ships that were delayed in coastal harbors, some for days, because there was no dunnage, that is rough lumber, with which to protect in transit such things as trucks, tanks, tractors, big guns and bombs. Many formerly in combat service have said that often the wood crate in which a Jeep was received was more valuable that the Jeep itself. Perhaps these statistics have more than passing significance since daily we read in the paper or hear over the radio that our men in Korea still depend on products from the forest and the farm woodland to keep them going. Much publicity has been given by news commentators and television newscasts to the prefabricated log bunkers used to protect the men from the mortar and artillery fire of the enemy.

Old wars leave their mark but soon fade into the background. New emergencies are the import of the moment. The American farmer was asked to furnish materials for war from his farm woodland and he did. He is now being asked to grow more timber so that the defense of the nation can be made strong and kept intact. Out of the tremendous drain which was bad for many of the farm woodlands came something, however, that was good. Farmers began to realize that their woodlands are a source of income. They began to see that a continuous and substantial revenue can be realized from them. They began to think and to plan and to profit. This importance of the farm woodland and the contribution it can make to our national security is a major factor in making forestery attractive and profitable enough to become an integral part of the farm enterprise.

Progress in Forestry due to Many Factors

This sudden realization on the part of many farmers of the importance and value of their woodlands is not the result of high prices or attractive profits from farm forest products during the past decade. There have been many other tangible stimuli. Fifty years ago the federal Forest Service and several state forestry departments started to give direct technical aid to individual woodland owners, most of whom owned large forests but some of whom were farmers. The numbers affected were few. The national forests and state forests have been examples of good forest practices to farmers living within or near their boundaries. Again relatively few have been affected. Agricultural extension work began in 1862, but not until 1914 was any form forestry work included in the extension program. And not until enactment of the Clarke-McNary Law in 1924 did extension begin to teach farmers to think seriously of their woodlands and plan for their management. This law also embarked the federal government and the states on a cooperative fire

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Figure 1.—Horse-skidding of logs to a landing for loading on trucks in the Clarence Lounsberry farm woodlot, Tioga County, New York. Logging of farm woodlot by the farmer himself is common practice.

control and tree planting program, the latter aimed directly at the farmers.

The Soil Conservation Service immediately after its formation initiated and integrated farm planning which included development and use of farm woodland. With establishment of the Soil Conservation Districts this work was intensified. Passage of the Norris-Doxy Farm Forestry Act in 1937 was a definite landmark in forestry on the farm. Technically trained farm foresters in three to five county project areas gave direct in-the-woods managing and marketing assistance to some 80 or 90 farmers each year. All these efforts and particularly the work of the farm foresters under the Norris-Doxey Act gave tangible proof to farmers that forestry is good business. They learned that forestry, if made a part of the farm enterprise, can add materially to farm income.

The Norris-Doxey Act was replaced by the Cooperative Forest Management Act of 1950. This new legislation brought all private forest land owners and forest products processors into the picture. It is aimed, however, at the small owner and the some 50,000 small timber operators.

Secretary Brannan's Memorandum #1278 is generally familiar. It is the most recent development in the department's efforts to further integrate forestry into farming. A memorandum outlining the forestry responsibilities of the Soil Conservation Service, the Production and Marketing Administration and the Forest Service under #1278 has been signed by the heads of the three agencies. It has been sent to all regional offices and State PMA chairmen for their guidance in farm forestry work.

The goal of all these programs and multiple efforts is more productive forests whether they be small or large. Major emphasis, however, is placed on getting better management on the small woodlands in private ownership, both farm and non-farm.

Forest Management Job Is Big

The job is a big one. Three and one-quarter million farmers own 139 million acres of woodland capable of producing crops of saleable timber. In addition, one million others—small non-farm owners, doctors, teachers, merchants, housewives and others—own around 122 million acres of small forests. Altogether some 261 million acres or three-fourths of all the private commercial forest land in our nation is in the hands of these four and one-quarter million small owners.

Past cutting practices, the needs of war, present day needs for wood, and high stumpage prices have all had their effect, an effect so serious that the hard core of the forestry problem in this nation is on these small woodlands which average 62 acres per ownership.

What are some of the problems?—We need to plant over 60 million acres of private land if adequate crops of forest trees are to be grown. Cutting practices need to be improved. In 1946, the year of the latest survey, only about 5 per cent of cutting on the small forests, farm woodlands included, was good enough to insure future crops of merchantable timber. Many farmers still permit the operator to cut everything. Farms and

other small properties are still sold with no thought of continuing management of the timber resources. Woodlands are burned for one reason or another. Grazing, particularly on farm woodlands with hardwoods, is still practiced to the detriment and almost total destruction of the young stands. The importance of farm woodland in the prevention of soil erosion and floods is not fully recognized by many farmers and other landowners. Too many heavily cut or grazed or burned-over woodlands are pouring water and soil onto fertile fields below them or into the springs and streams. The forest as a home for wildlife—both game and fish—is not fully appreciated regardless of the intensive efforts of both public and private agencies to make owners and sportsmen alike aware of such tangible values.

What should we do to get better management on our farm forests—and when I say farm forests I must include the other small non-farm woodland areas which are of equal importance? In other words, what job remains if the small forests are to be made more productive?

All farmers with woodland must be shown that forestry can become a part of the farm enterprise. They must learn that it can become just as profitable as raising chickens, cattle, hogs, corn or any other crop. Farmers must realize that their farm woodland is a valuable segment of the farm property. Based on 1946 selling prices the estimated market value of the farm woodland in America is almost two billion dollars. This is a tremendous capital value to have invested in land and trees. It is an investment that if profitably managed can yield interest returns of anywhere from 5 to 15 per cent or more per year. It is a capital investment that grows because trees grow. And in a well managed woodland their rate of growth is often greater than the return on any other enterprise on the farm. Farm woodlands, however, that are producing only one-third to one-half of their potential capacity are not in this category. The farmer should know that usually less effort is required to grow and tend a crop of trees than any other crop. Nature does much of the work for him. It is a crop that can be harvested at the desire of the farmer. A month or a year's delay doesn't matter much. Few if any other crops on the farm are this versatile.

To be a part of the farm enterprise forestry operations should be carried on by the farmer himself. When trees are sold on the stump the buyer or timber operator cashes in on his own labor and that of his men. He makes all the profits in intervening steps from the log to the saleable lumber. When trees are sold lump sum or by the boundary without any knowledge of the amount of the timber, the farmer generally loses. He should sell measured amounts of timber just as he sells his other products by weight, bushel or gallon.

The farmer who uses his own labor and periodically cuts and harvests the products from a well managed woodland realizes the greatest profits. A woodland which produces maximum profits through the sales of products can also be made to exert maximum beneficial influence on the prevention of soil erosion, on water flow for springs, wells, streams and ponds, on habitat for wildlife and on recreation.

Obstacles to Overcome Are Numerous

What obstacles remain to keep farmers from making forestry a part of their farm enterprise? There are quite a few. These obstacles are often troublesome and beyond the control of the farmer or small woodland owner. Many farmers are unable to get on-the-ground technical advice and assistance to solve their more complex forest management problems. Farmers can learn to do the simpler forest management jobs. They can learn to measure trees and scale logs. They can learn to do a good job of cutting. They can become proficient in making a good sale. There are times, however, when silvicultural requirements of the timber stand are so difficult that they can be recognized and prescribed for only by a technical forester. The amount of growing

Figure 2.—An extremely hot fire burning in litter and down brush in a young hardwood stand. The prevention of such fires is frequently the first step needed in bringing a farm woodlot under good management.

Figure 3. The use of stems of cordwood size to make paper, as at this mill in Florida, offers farmers a profitable outlet for tops, and small trees taken from thinnings and improvement cuttings.

stock, the annual growth, the allowable cut, when and what to thin, and other management measures must be worked out in the woodland by the forester and farmer together.

There are now 250 service foresters employed and supervised by state forestry departments in 38 cooperating states. This is a joint Federal-State cooperative forest management program authorized by the Cooperative Forest Management Act of 1950.

To do the forest management job on farm woodlands and other small forests adequately, 2,000 such service foresters should be operating in the cooperative forest management program.

There are few opportunities for the small forest owner to borrow money on long term credit. His woodland is run down. He can not do anything to improve it unless he is able to borrow money for a long period with his woodland and its productive capacity as security. A start to hurdle this obstacle has been made. A private company in Georgia has recently embarked on a program of such loans. A federal land bank in the South has been making loans on woodland for several years. Recently a few banks in small communities have been extending credit to woodland owners and farmers who want to grow trees as a continuous crop and who have the services of a forester available. Foresters, economists, bankers and public agencies must work consistently toward a solution of this problem if better management on many small woodlands is to be a reality.

Another obstacle is the inability of the small woodland owner to combat insects or diseases when they strike his forest. Often he fails to notice an insect infestation or it moves down upon him from adjoining timberland. There is danger of complete destruction of his woodland enterprise unless a general attack against the infestation is possible. Here again the assistance of public agencies is needed.

While I dislike to classify the local sawmill man as an obstacle to good farm forestry, his importance to such a program cannot be over-emphasized. The small sawmill man needs to be shown that good cutting practices will keep him in business. A woodland devastated by destructive cutting offers no more business for the operator for many years. A woodland carefully cut with provision for future yields at short intervals is a source of continuous income for the local timber operator. If he lines up enough such well-managed woodlands for cutting he can stay in business. Many operators have learned this lesson and are cooperating with small woodland owners and foresters in better forest management practices.

While the obstacles I have mentioned often delay the application of forest management practices in the small woodland, they can be overcome. They are being overcome gradually as a result of the untiring efforts of organizations such as the Soil Conservation Society of America. The day is approaching when few farmers will accept $500 cash for all the timber on the back forty that has not had an axe in it in more than 30 years. The farmer who makes forestery a part of his farm enterprise will know what he is selling. He will have a complete plan for his woodland which in many cases will be an intergral part of a complete farm plan. He will know just about all there is to know about the timber on his back forty, what species are present, when it should be thinned, what is the merchantable volume, when it should be cut, how many board feet can be removed each year or in short intervals so that the productive capacity of the woodland will be maintained at its maximum. He will plan for the best time to do his own cutting. He will have knowledge of markets and prices and he will plan time for improvement work in his woodland just the same as he does for improving his pastures, building terraces, maintaining farm buildings, culling his laying flock or carrying out any other of his farm enterprises.

When that time arrives, the progress we will make in integrating forestry into farming will be such that even the great strides made in the past decade will be far excelled.

Soil Conservation Districts are People Working Together

WATERS S. DAVIS JR.

LAST SUMMER an executive of one of the large farm equipment manufacturing companies told me, "Soil Conservation Districts are the greatest thing that ever hit American agriculture. They have done more good for the farms of this country than anything in the past century.

"But", he went on to say, "Soil Conservation Districts have one serious drawback. Very few people really know what they are, how they operate, or who runs them! I'll bet you a new hat right now that if everybody in this country knew what a Soil Conservation District was, we would be saving ten times as much soil as we are today. Everybody and his brother would pitch in and help."

How Many Really Know?

That comment caused me to think. I began to wonder just how many people really did know what Soil Conservation Districts are.

When I returned to my office, I had the girls type up some penny postcards with these words across the top, *"I think a Soil Conservation District is. . . ."*

During the next few days, I sent five of these postcards to various people around the country and asked the person who received them to get the next five people he met to fill in the blank space after that sentence, *"I think a Soil Conservation District is. . . ."*

The results shocked me; my friend in the farm equipment business knew what he was talking about.

Here are just a few of the replies I received; they are a pretty good cross-section of the 150 and some odd answers that came back:

A life insurance company official said, "A Soil Conservation District is a subdivision under the Soil Conservation Service of the U. S .Government."

A garage owner in a midwest city said, "A Soil Conservation District is a federal agency helping farmers do soil conservation such as plowing and contouring."

A policeman wrote back, "A Soil Conservation District is a parcel of land set aside by the government to test the soil's reaction to certain types of fertilizers."

A lawyer said, "A Soil Conservation District is a plan to spread the taxpayers money to everyone. It is a plan of financial distribution that should be discouraged."

Those answers were painful. They showed not only a complete ignorance of Soil Conservation Districts, but worse, they showed a dangerous misunderstanding that could do nothing but harm to the entire Soil Conservation Districts movement. Scores of postcards came back with the simple—and honest statement—scrawled across the top, *"I don't know."*

A Farm Editor Knows

There was one bright spot in this little experiment, however. A farm editor (whose name I will never know unless he reads this story and tells me) gave a thoroughly intelligent, and accurate explanation of a Soil Conservation District.

Here is what he, or she, wrote:

"A Soil Conservation District is the pure, undistilled essence of democracy. It is the people of a community, of themselves and by themselves, working together for themselves. In their effort they have the benefit of their government working with them.

"This is in marked contrast to so many present day approaches where the people either work for the Government or sit by and expect the Government to work for them.

"Furthermore, Soil Conservation Districts hold the only hope for agriculture in this country. Continued high productivity can be obtained and maintained only through an expanded application of soil and water conservation."

That farm editor is undoubtedly doing his best to get the true facts about Soil Conservation Districts in front of his readers. And it is fairly certain that those who read his farm magazine, or newspaper, will not have the misunderstanding and mis-information which so many other people throughout the country seeem to have.

But for every one farm editor in the country who knows the facts as well as this man, there are hundreds of others who do not.

From the replies to my postcard experiment, it was plainly evident that most people associate Soil Conservation Districts, either directly or indirectly, with the federal government. How could so many people be so 100 per cent wrong in their ideas?

The answer to this $64 question probably goes back to the early nineteen thirties when the people of Amer-

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Most Soil Conservation District officials serve without compensation of any kind They gladly give their time to their jobs and usually pay large sums from their own pockets for travel and other expenses But the reward is often great as it is for this Ohio District board of supervisors shown checking up on the progress of conservation work of a cooperator.

ica first became conscious on a mass scale of the need for doing something about soil conservation.

In those days, the great dust storms on the southern and northern Great Plains had created something of a national emergency. The Federal government moved in with an army of CCC boys, WPA workers, and soil experts.

Not a Government Job

Settling the dust of the thirties was largely a government job. This is probably what most people remember. They do not realize that the national government stepped out of the picture and transferred the job to the American farmer and rancher.

The transfer began in 1937 when the first Soil Conservation District was organized by a group of farmers in the Broad River watershed of North Carolina.

This District ushered in a new era in American agriculture.

Instead of calling on the government to furnish the machinery, seed, fertilizer, lime, trees, and scores of other things needed for soil conservation, these farmers said in effect, "*We'll do all those things ourselves. We are organized under a new State law that gives us legal standing as a unit of the North Carolina government. We are financially able, and willing to handle our own affairs. All we need is some help on technical problems. "If you will assign soil scientists to our District to examine and map our soils, erosion engineers to help our farmers design terraces and other structures, crop rotation specialists, and other technicians occasionally, we'll guarantee to keep them busy and see to it that the American taxpayer gets more than a dollar back for every dollar it costs.*"

Since 1937, American farmers have repeated the process of organizing a Soil Conservation District nearly 2,500 times. Every State and most U. S. Territories and possessions now have laws which make it possible for farmers and ranchers to organize on a community basis for soil conservation. About 82 per cent of all the privately owned farm land in the country is now within boundaries of a farmer-organized, and farmer-managed Soil Conservation District.

The farm editor I mentioned above, pin-pointed the reason why Soil Conservation Districts have made such phenomenal growth, "*It is the people of a community, of themselves and by themselves, working for themselves.*"

Government can help. But it cannot do the soil conservation job in America. Only people who live on, and till the soil, day after day and year after year, can do all the many things that must be done to keep the nation's land healthy and productive.

Over the past ten years thousands of American farmers and ranchers have taken soil conservation into their hearts. It has become a living, everyday part of their lives. They are devoting endless hours of their time and large sums of their own money to the job of getting entire communities interested in conservation methods.

A "Torch" to Carry

These people are not on any government payroll. They are your neighbors and mine who are "carrying a torch" for a cause they know is right, and vital to the future of our country.

About 12,500 are serving as volunteer officials of local Soil Conservation Districts. In most States they are called Supervisors. In some they are known as Commissioners, or Directors. All but a few serve without salary or other compensation. Several State legislatures make small appropriations to help with travel expenses.

In a very real sense, this is American grass roots democracy in action. Neighbors helping neighbors and all working toward the common goal of permanent soil and water conservation.

Before any Soil Conservation District can be organized, farmers in a community must sign a petition asking for a District. In most States, this petition goes to a State Soil Conservation Committee, Board, or Com-

The Wood River and Gooding Soil Conservation Districts in Idaho hold frequent on-the-farm meetings to introduce new methods of "conservation irrigation."

mission. The State agency then holds public hearings in the community to find out how many people are really interested in doing something about soil conservation, where the District boundaries ought to be, and what objections, if any, people may have.

The next step is to put the issue to a vote at a special Soil Conservation District referendum. If the District is voted in, local farm and ranch people are elected to manage its affairs. In some States, one or two members of District governing boards are appointed by the Governor or State agency. In all states, however, elected farmers make up the majority membership.

After a Soil Conservation District is organized and its officers selected, farm and ranch people in the District decide what they want to do and how they will do it. Usually, the first step is to draw up an over-all District program.

In my own Brazoria-Galveston Soil Conservation District in Texas, we called in bankers, businessmen, county officials, the highway people, scores of farmers and ranchers, our county agent, Soil Conservation Service technicians, teachers, and many others, to help work out our District program.

Theses were all people in our community who knew local conditions and the local problems we had to deal with. No one in the State capital at Austin, nor at Texas A & M, nor in Washington, D. C. could do this job. They did not know our local conditions. More important, they did not know what we, the local people wanted.

Even if some government agency could have drawn up a nice, high-sounding program for us, it would have been doomed to failure because it wouldn't have been, "of the people, by the people, and for the people themselves," as my farm editor friend said.

What is "Local"?

During the recent political campaign millions of words were uttered about *"returning farm programs to local control."* The phrase made good listening. It undoubtedly produced some votes.

But the word *"local"* apparently has a good many interpretations. Some say that having all services to agriculture handled by State agencies of government makes them *"local."* Others say farm programs are *"local"* when the federal government has nothing to say about them. A few insist that the only *"local"* programs are those administered on a county basis.

Without getting into that argument, it is safe to say that no movement in America is more *"local"* than Soil Conservation Districts. Districts are organized by he people of a community because they want to work together to get a big job done. The community may be no larger than a small valley. Or it may take in a fairly sizeable watershed that covers parts of several counties.

The size of Soil Conservation Districts varies all over

America. In some States, they follow rather closely along county lines. But regardless of their size or location of boundaries, the underlying principle is the same. People have banded together in a common cause. They are solving their own problems by putting local self-government to work.

When Soil Conservation Districts call in government agencies to help, they make it clear that the role of government is to assist, not to dominate, or control. Farmers and ranchers who pay the government specialists' salaries with their taxes are the "boss.' The specialists are working for the people, not for some distant bureau in the State capital, state college, or Washington, D. C.

This new relationship between people and their government has been a powerful force in wiping out jealousies between government agencies, eliminating duplication of effort, and getting many agencies to work together as a unified team.

There are Many Helpers

Typical Soil Conservation Districts about the country are now calling in specialists from their State colleges to solve scientific problems and help with the education of all farmers in the District. Nearly all Districts make use of the highly trained and skilled technical workers of the U. S. Soil Conservation Service. Many are using the skills of the U. S. Forest Service, the Bureau of Land Management, the federal Fish and Wildlife Service, and other national agencies.

Most Districts about the country are now calling in State agencies of many kinds, in addition to their State Extension Services and Experiment Stations.

State Fish and Game Commissions are showing Districts in scores of States how to increase their wildlife and make fishing better. Hundreds of State and County highway departments have working agreements with Districts to make sure that roadside ditches and highway cuts and fills fit in with the over-all conservation job.

But along with these scores of government agencies, Districts are getting invaluable help from dozens of private sources. My tractor-manufacturing friend is helping. His company has designed special new implements to help farmers do a better job of installing conservation measures. His company and many others are also spending millions of dollars in advertising and other ways to encourage farmers to see the wisdom of soil and water conservation.

A Job For All

In most Soil Conservation Districts, people in the towns and cities are pitching in to help. They do this in many ways such as serving on advisory committees to help District officials. Merchants, bankers, lawyers, newspapermen, educators, and radio station owners, are helping with such things as finance, publicity, mass education, and state and national legislation.

These are some of the reasons why Soil Conservation Districts — the farm and ranch people of America—are well on their way toward changing the face of our rural landscape. It will be a more beautiful and bounteous face when they finish the job.

Land—Key to Industrial Progress

(*Continued from page* 13)

Agricultural chemical companies carry on continuous research to develop products that will aid erosion control, plant growth, and animal health. New machines, materials, and techniques for establishing lasting grass and forest cover on the land continue to come out of great American industries. In the fields of chemistry and nuclear physics lie great hopes for still newer products for land treatment.

The more than 2400 locally-organized and locally-administered Soil Conservation Districts operating under State enabling laws offer vast opportunities not only to local, State and Federal agencies, but to individuals, corporations, and organized groups, in accelerating the much needed resource conservation effort.

Perhaps similar conditions, opportunities and proposals can be made for the whole field of non-renewable resources. Many here are more capable of discussing this phase of our conference than I. Let's go to work —all of us in industry, educational institutions, and government—and see what can be done in both these fields of real wealth—our non-renewable resources.

Continuous Plant Cover—The Key to Soil and Water Conservation

J. H. STALLINGS

This paper explains the role of plants in preserving and building soil; also why continuous plant cover is essential to a successful soil and water conservation program. It shows that the primary function of plant cover in preserving soil is to protect it from erosion by absorbing the destructive energy of wind and falling raindrops. The paper further points out that the major differences between the so-called "soil-depleting" and "soil-improving" crops is, in fact, one of cover and the beneficial effects of cover in protecting the soil from raindrop impact and resulting damages to the soil. The second and concluding part of this paper will appear in the March issue of the Journal.

NATURE PERFORMS her marvelous feat of building soil by means of "*holding*" and "*developing*" actions. These actions are performed simultaneously by the countless thousands of types and species of plants inhabiting the earth. The first step in the soil-building process is the "*holding*" action. For this purpose Nature has developed plans suitable for almost every possible combination of soil and climatic conditions.

Moss and lichens often start the "*holding*" action. They form a protective covering over the rock surface that catches and holds dust. This cover also holds the soil in place as it develops from the surface downward (Figure 1). As soon as the rocky surface has changed sufficiently to support higher forms of plant life, the mosses and lichens are gradually replaced by the next higher plant form in the ecological scale. Further soil improvements in turn are followed by the invasion of still higher forms of plant life until the climax species is reached. At all times, however, the ground surface is protected by a blanket of plant growth best adapted to the existing environmental conditions.

The second or "*developing*" step in the soil-building process consists of changing the rock into soil. This step cannot be taken, however, before the "*holding*" action is effective. This, too, is a slow process that requires centuries and involves many changes of plant cover before the climax phase of vegetation is reached. If at any time this plant cover is reduced or removed so that it becomes inadequate to protect the surface, the soil begins to erode and deteriorate. Once this process sets in, the succession of plant life which was active in building the soil is thrown into reverse. As the soil environment becomes less favorable, the lower forms of plant life follow in succession.

This "*holding*" action was not known to exist until Nature's balance between soil-building and soil-destroying forces was upset by removal of the native plant cover. Even today we do not fully understand or appreciate the nature, extent, and significance of the tremendous forces set in motion by this act. Removing the native plant cover exposed the bare soil to the full force of wind and water. The erosive action of these agents stopped the soil-building process and threw the whole procedure into reverse. Even now, few people realize that this "*holding*" action is essential for soil and water conservation and, in turn, soil improvement.

The part played by wind in the soil erosion process and methods for its control were presented in other papers (38, 41). Most of the force of falling raindrops is expended as the rain beats against the ground surface. Here then is where the resistance is needed to reduce or prevent erosion damage. The major role of cover is to provide resistance to the vertical force of falling raindrops rather than to the horizontal force of overland flow (5, 15, 25).

Figure 1.—Formation of residual soil—Generations of liverworts growing on solid rock have gradually brought about decomposition of the surface portions of the rock. The addition of organic matter in the form of decaying remains of liverworts has resulted in the formation of about one-half inch of soil. Peeling back the liverworts from the rock surface lifts up the soil.

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Figure 2.—About two inches of soil were removed from this plowed field in South Carolina during one rain, mainly as a result of raindrop splash. The stone capped pedestals show that the force causing the erosion was applied from above, as by falling raindrops, and not from the side, as by flowing surface water. The dead plant roots in the foreground protected the soil immediately beneath them while that between and to the sides was splashed away. Little erosion took place in the background where the surface of the ground was protected by plant cover.

The most productive portion of the soil is at the surface. As plant life becomes established on the rock surface, organic residues accumulate on top of the ground. Their soluble portions are leached into the ground by rain or snow melt. At first the thin layer of soil at the ground surface absorbs these substances (particularly the soluble organic portions which produce humus) and becomes dark in color. As further plant residues are accumulated on the ground surface, the soil layer becomes thicker and the humus penetrates deeper. But humus accumulates faster at the surface than at lower depths in the soil.

Raindrop Splash the Major Factor in Soil Erosion

Water erosion has generally been thought of solely as the removal of soil by flowing surface water. However, we know now that raindrop impact is the main cause of erosion on cultivated land and without it there would be little erosion (Figure 2). The amount of damage caused by falling raindrops is proportional to the kinetic energy of the drops. It has been estimated that the kinetic energy of falling raindrops ranges from 1,000 to 100,000 times the work capacity of surface runoff (14, 25).

The erosion process requires energy to detach and carry soil from its original site. The force generated by surface flow is determined by its concentration and speed of movement downhill. Flowing water gains energy by gaining mass as it concentrates at the foot of a slope, or by gaining velocity as it flows down a steep slope. Due to the nature of its source of energy, surface water does not flow evenly over the surface of a field and therefore could not cause so-called sheet erosion—which accounts for most of the soil loss from cultivated land.

Raindrop impact, however, is distributed uniformly over the entire surface of a slope. Moreover, it is effective only when the bare soil surface is exposed to the beating action of raindrops. Raindrops detach soil particles and feed them into surface flow, which moves downhill. This combined flow and impact action accounts for 95 to 100 per cent of the sediment removed from fields (25).

Plant Cover Intercepts Falling Raindrops

Under field conditions, plant cover controls splash erosion (Figure 3). The effectiveness of plant cover in preventing soil splash depends upon the amount present when the rain falls. Both the density of cover (to act as a shield) and the weight or bulk of the cover (to absorb the energy of the raindrops) are important in protecting the soil.

Effectiveness of cover is proportional to the amount present. Weight (in pounds per acre) and coverage (per cent of ground surface covered) are practical measurements of about equal value (28). However, the closest indication of effectiveness is obtained when weight is multiplied by coverage to give an index of "effective weight."

The growth forms of different crops influence their effectiveness in controlling splash erosion. Close-growing crops of medium height, such as oats, wheat, and vetch, have almost identical values for the same weight of cover. Tall-growing crops, such as sweetclover and cotton, provide less protection than close-growing crops for the same weight of cover in amounts above 1,000 pounds per acre (28). This, no doubt, is due to the greater bulk and weight of material present in taller crops for a given amount of surface coverage. The reason tall, coarse crops do not provide as much protection as close-growing crops is because of their more open canopy and the action of intercepted raindrops falling from their foliage.

For 90 per cent effectiveness, approximately 2,500 pounds per acre of close-growing crops or 4,000 pounds of tall, coarse crops are required (28). Below this point, effectiveness declines rapidly as the amount of cover is reduced and the difference between growth forms become less important. The mid-points appear at about 85 per cent effectiveness, which requires approximately

2,000 pounds of close-growing crops or about 3,000 pounds per acre of tall, coarse crops. At 1,000 pounds per acre there is no significant difference in the kinds of crops; both are 60 per cent effective.

The inclusion of a so-called "cover crop" or "soil-depleting" crop in a rotation grown on a certain field does not of itself mean that the field is or is not adequately protected from severe rainstorms. At some period in the life of most crops a maximum rate of erosion is possible, due to inadequate cover whether they are classified as soil-improving or soil-depleting. At other periods, the danger from erosion may be nil even with some so-called soil-depleting crops because they produce a greater bulk of cover at some seasons than many crops grown especially for erosion control.

Plant cover has a controlling influence on splash erosion. When there is sufficient canopy to intercept all the drops and absorb most or all of the energy of the rain before it reaches the soil, even the most easily detached soil is not disturbed.

Soil-Depleting and Soil-Improving Crops

Corn, cotton, peanuts, and the other so-called soil-depleting crops provide inadequate plant cover during the critical summer period of erosion-producing rains (Figure 4). On the other hand, soil-improving crops, once established, provide plant cover throughout their entire growth period. This lack of adequate plant cover and its protective influence on the soil on the part of the so-called soil-depleting crops, then, is the major difference between soil-depleting and soil-improving crops. In soil-improving crop systems usually one or more legumes are included which add some nitrogen to the soil. The main advantage of soil-improving crops is more effective cover.

This was illustrated by results from the Soil Conservation Service project at Clarinda, Iowa where the addition of 180 pounds of nitrogen per acre in 1952 to plots that had grown corn continuously for the past 20 years eliminated the trouble which caused low yields. Since 1932, corn has been grown continuously on one series of plots and in a 3-year rotation of corn, oats, and meadow on another. The corn in each series received the same fertilizer treatment until 1952. The fertilizer treatment was the same again in 1952 except for the fact that the continuous corn plots received 180 pounds of nitrogen per acre. The yields in 1952 were 103.0 bushels per acre on the continuous corn plots and 98.4 on the rotation plots (32).

The average annual yields of corn in bushels per acre by 5-year periods and for 1952 for both series of plots are given in Table 1.

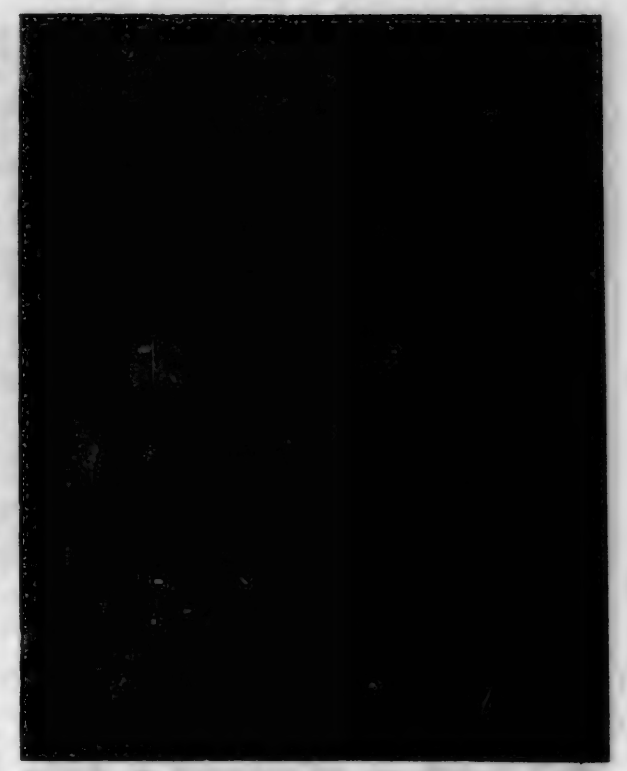

Figure 3.—Plant cover intercepts falling raindrops, absorbs their kinetic energy and eliminates their damaging impact action of the ground surface.

Table 1.—The average annual yield of corn in bushels per acre by 5-year periods and for 1952 for corn grown continuously and in a 3-year rotation during the period 1932 to 1951, inclusive, and 1952

Cropping system	Average annual yields in bushels per acre				
	1932-36*	1937-41	1942-46	1947-51	1952
Continuous corn	23.9	32.5	23.9	17.8	103.0
Rotation	25.8	57.0	72.0	83.9	98.4

*Includes the drought years 1934 and 1936 when the crop was a failure

Beginning with the second 5-year period the yield on the continuous corn plots declined from 32.5 bushels per acre to 17.8 for the fourth 5-year period. During this time the yield on the rotation plots increased from 57.0 bushels per acre for the second 5-year period to 83.9 for the fourth. The difference between the yields of these two series of plots also became greater with time. It was 1.9 bushels per acre for the first 5-year period, 24.5 for the second, 38.1 for the third, and 66.1 for the fourth.

When land is kept in cultivated row crops for any length of time the tendency is for yields to decline steadily, and in some cases rapidly. As cultivated row crops in a cropping system are replaced by sod crops, yields improve. Because of these facts the former crops have become known as soil-depleting and the latter as

soil-improving. However, if we consider the amount of plant nutrients removed from the soil by these two groups of crops, we often find that the worst offenders in the soil-depleting group actually remove lesss plant nutrients than the soil-improving crops. This is especially true where stalks and other crop residues of the soil-depleting crops are left in the field.

This point may be illustrated by comparing the amount of plant nutrients removed by hay with the amount removed by the grain of the corn and oat crops in a 5-year rotation with three years of hay and in a 3-year rotation with one year of hay (17). The number of pounds per acre of calcium, phosphorus, nitrogen, and potassium contained in the grain of the corn and oat crops and the average pounds per acre of the same nutrients removed in hay for the 5-year rotation are given in table 2.

Table 2.—Average pounds per acre of plant nutrients removed annually by the grain of corn and oat crops and alfalfa-brome hay in a 5-year rotation of corn-oats-hay-hay-hay during the period 1947-50.

Crop	Calcium	Phosphorus	Nitrogen	Potassium
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*
Corn	0.35	9.46	52.55	10.86
Oats	2.01	7.36	42.82	8.92
Hay	42.90	13.52	109.31	103.43

Except for nitrogen, the figures presented in Table 2 do not show corn to be soil-depleting in comparison with hay. Since the hay crop contained alfalfa, it is presumed that the nitrogen removed in the harvested hay was approximately equal to the amount taken from the air by the crop. Thus the original supply of nitrogen in the soil was not changed. However, the nitrogen removed by the corn crop was a net loss to the soil's supply.

Similar figures are given in Table 3 for the crops grown in a 3-year rotation.

Table 3.—Average pounds per acre of plant nutrients removed by the grain of corn and oats and by hay in a 3-year rotation of corn, oats, and hay.

Crop	Calcium	Phosphorus	Nitrogen	Potassium
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*
Corn	0.31	8.40	46.67	9.64
Oats	1.68	6.15	35.81	7.46
Hay	32.85	7.55	65.27	65.27

The data in Table 3, for the 3-year rotation, confirm those from the 5-year rotation shown in Table 2. If corn had been grown continuously, the yields would have been smaller and the plant nutrients removed by the crop would have been even lower.

This indicates that the so-called soil-depleting crops are really not depleting after all. Nor is the term "soil-improving" an accurate description of the crops in that group. More accurately (as will be shown later) the chief difference between these two groups is the amount of plant cover they provide and its effect on erosion and other deteriorating effects on the soil.

Plant Cover and Soil and Water Losses

It is generally recognized that, under most systems of management, land cropped to grass and trees does not present as serious an erosion problem as land devoted to cultivated crops. In fact, erosion is practically nonexistent on land protected by ample plant cover, regardless of the kind and nature of the cover. Likewise the loss of water as runoff is directly affected by the plant cover. As plant cover decreases or deteriorates, erosion and runoff losses become progressively higher.

The extent to which any cropping system is effective in reducing soil and water losses depends largely upon the proportion of close-growing vegetation used and the length of time and season of the year when it occupies the land. Crops that provide protective cover during the months of erosion-producing rains are especially valuable in conserving soil and water.

Table 4.—Average soil loss per acre in tons and runoff in per cent of rainfall annually over a 14-year period, (26).

Treatment	Soil	Runoff
Continuous bluegrass	.34	12.0
Rotation: corn, wheat, clover	2.78	13.8
Continuous wheat	10.09	23.3
Continuous corn	19.72	29.4
Fallow	41.65	30.7

A crop rotation of cotton, wheat, and sweetclover reduced soil loss 74 per cent and runoff 34 per cent annually, compared with continuous cotton during a 21-year period at Guthrie, Okla. (12). Both wheat and sweetclover greatly reduced erosion, but the amount of soil removed from the wheat plot was six times as great as from the sweetclover. During a 1.69-inch rain on July 21, 1950 (with 5-, 15-, and 30-minute intensities of 5.64, 3.84, and 2.30 inches per hour, respectively) the continuous cotton plot lost 41.65 per cent of the rainwater as runoff and 2.035 tons of soil per acre. The cotton plot in the rotation lost 39.40 per cent of the rainwater as runoff and 1.835 tons of soil per acre. The wheat plot lost 47.51 per cent of the rainfall as runoff and 0.098 ton of soil per acre. The sweetclover plot lost no water or soil and the Bermuda sod plot lost only 0.47 per cent runoff and no soil by erosion.

Bare, hard, fallow land lost 27.92 per cent of the total rainfall as runoff and 22.20 tons of soil per acre annually during the period 1930-41, inclusive. (11).

Figure 4.—Cotton plants in this field did not furnish enough cover for adequate protection of the soil against the impact of falling raindrops. Land planted continuously to cotton in Oklahoma lost the equivalent of all the crop residues left on the ground and 1,860 pounds per acre annually of the soil's original supply of organic matter over a 10-year period. It also lost an average of 18.9 tons of soil per acre annually by erosion.

During this period, land plowed and planted continuously to cotton lost 12.03 per cent of the rainfall as runoff and 16.06 tons of soil per acre annually. Similar soil in Bermuda grass sod lost only 0.9 per cent of the rain as runoff and 0.02 ton of soil per acre annually.

Land in Nebraska plowed the previous year and planted to corn lost almost twice as much water and four times as much soil as land that was subsurface-tilled and protected with wheat residues (13). Combined wheat stubble and straw left undisturbed on the soil surface reduced runoff loss to 2.39 per cent of the rain that fell, and soil loss to one per cent of that on bare land. Land planted to oats after corn had been harvested, stalks removed, and land disked, lost 10.852 tons of soil per acre from January 1 to June 30, 1942. Adjacent plots with cornstalk residue and subtilled before planting oats lost 0.613 ton of soil. Plots planted to corn (after the preceding sweetclover crop had been turned under) lost 12.364 tons of soil from one rain. But an adjacent sweetclover plot which was subtilled before planting to corn lost only 1.152 tons of soil.

Green manure plowed under in the fall was 65 per cent less effective in controlling erosion than when left on the surface in the fall and the land cultivated with sweeps (18). Where the green manure was plowed under, the soil loss was 57.8 tons per acre compared with 20.22 tons when left on the surface. Land adjacent planted continuously to corn lost 111.7 tons of soil per acre annually during a 6-year period. The soil loss for small grain was 16.8 tons per acre annually but only 0.68 ton for hay.

Land in Georgia planted continuously to cotton lost an average of 24.95 tons of soil per acre annually during the period 1940-47 (7). Soil loss was reduced to 15.39 tons by using a two-year rotation of corn-crotalaria and cotton-vetch. A 3-year rotation of oats-lespedeza, lespedeza, and cotton reduced erosion to 3.38 tons per acre annually. Of the 10.15 tons per acre of soil lost during the three years of the rotation, 7.08 tons were lost during the year the land was cropped to cotton.

From April to September 1940, unmulched land in Georgia lost 12.57 tons of soil per acre compared with 0.2 ton for mulched land (20). During this period 32.75 per cent of the rain that fell was lost as runoff from the unmulched land, compared with 1.43 per cent for mulched land. A plot which had been disk-harrowed, planted to Kobe lespedeza, and mulched with straw lost only 1.2 per cent of the rain that fell as runoff and 0.24 ton of soil per acre from April 1940 until the end of that year (19). A companion plot, similarly handled except for being mulched, lost 24.2 per cent of the rain as runoff and 12.62 tons of soil per acre during the same period.

A plot in Mississippi, planted continuously to cotton, lost 58 percent of a total rainfall of 130.7 inches as runoff during a two-year period (24). For individual rains the runoff amounted to as much as 96 per cent of the precipitation. Soil loss on this plot exceeded 195

tons per acre for the two-year period. The runoff from broomsedge in an old field amounted to only slightly more than one per cent of the rainfall, and from an oak forest, it was less than one per cent. Runoff from these two classes of cover did not exceed 5.05 and 3.10 per cent of rainfall, respectively, for individual storms. Erosion from such land was almost negligible.

It was found that a wheatgrass type of vegetation in Idaho minimized flash runoff and erosion even under conditions of torrential rainstorms and steep slopes (9). As long as the character of the cover was unchanged and its original density maintained, it could be grazed by livestock and wild game without greatly reducing its effectiveness in controlling erosion and runoff.

In Virginia, close-growing crops (such as wheat) prevented excessive rates of runoff from Dunmore silt loam on slopes up to 30 per cent, while high rates of runoff occurred when corn was planted on slopes exceeding ten per cent. Hay crops provided almost complete protection against both runoff and erosion. In Missouri the soil in the runoff water was lower from densely vegetated areas than from areas occupied by wide-spaced crops (27).

Plots of Houston clay in Mississippi, covered with straw at the rate of two tons per acre immediately after cultivation, lost only 0.1 ton of soil per acre from July 1 to December 31, 1942 (45). During this period an adjacent plot which was cultivated but not covered with straw lost 21 tons of soil per acre. The straw-covered plot lost six per cent of the 14.83 inches of rain that fell whereas the unmulched plot lost 44 per cent.

In South Carolina, Cecil clay loam mulched with Kobe lespedeza and crimson clover hay at the rate of four tons to the acre lost only 0.75 ton of soil during the period August 1939 to January 1942, compared with 89.15 tons for adjacent land that was not mulched (29). The effect of plant cover as an erosion control measure was demonstrated during a 4.64-inch rain which occurred on August 21-22, 1946. A plot which had been disked so as to leave as much of the residues from the preceding crop on the soil surface as possible lost 275 pounds of soil per acre, whereas a similar plot without plant cover which had been plowed lost 1,767 pounds (30).

When stones larger than two inches in diameter were removed from a stony soil in New York, the loss of water was doubled and the soil loss tripled, in comparison with a similar area where the stones remained in place during a 6-year period (22). A mulch reduced the water loss from 1.93 inches to 0.16 inch and the annual soil loss per acre from 9,132 pounds to just a trace during a 3-year period, in comparison with a similar soil that was fallowed. Erosion losses were as much as 149 times greater from unmulched plots than from plots protected by straw mulch in Illinois (42). During these tests 91 per cent of the ground surface was protected from the direct impact of raindrops by the mulch. Corn stover was more effective when used as a mulch than soybean residues. The corn stover left only 13 per cent of the ground surface unprotected from raindrop impact, in contrast with 27 per cent for the soybean residues.

An annual average of 51 tons of soil per acre was lost from Shelby silt loam planted continuously to corn (34). But the rate of soil loss was reduced to an average of nine tons per acre annually (or 80 per cent) when corn was grown in a 3-year rotation of corn, wheat, and red clover-timothy. During the same period an adjacent plot of bluegrass sod lost practically no soil.

The addition of wheat, red clover, and timothy to the cropping system provided better plant cover during the time they occupied the land. The continuous corn plot was practically bare, except for a brief period during the latter part of the corn-growing season. On the other hand, the rotation plots were protected by plant cover for a much longer period of time. Here the land was protected by plant cover except for the portion of the year when corn was grown. Corn was followed by wheat in October. Timothy was either planted in the wheat in the fall or the next spring, and red clover was planted in the spring. After the wheat was harvested, the clover and timothy continued to furnish good cover throughout the remainder of the year and all through the third year of the rotation until April of the corn year, when the ground was plowed for corn. The effectiveness of plant cover in controlling erosion is illustrated in Figure 4.

Pine and hardwood litter applied as mulch gave almost complete control of runoff and erosion over an 11-year period in North Carolina (8). Both forest cover and permanent sod were equally effective in controlling runoff and erosion. The use of wheat and lespedeza in a 4-year rotation with cotton and corn reduced soil loss to an annual average of 14.4 tons per acre for the rotation, compared with 31.2 tons from continuous cotton and 66.2 from bare land.

Frequent burnings of a forest plot over a period of seven years increased runoff more than a hundredfold, compared with that lost from either cotton or corn in a 4-year rotation. The amount of erosion increased from practically none to nearly eight tons per acre. The water drained faster from the cultivated watershed than from the protected, forested watershed.

The effectiveness of plant cover in controlling erosion and runoff is further emphasized by comparing soil and runff losses for one-, two-, and three-year-old stands of hay. These losses were 6.53, 0.39, and 0.10 tons of soil

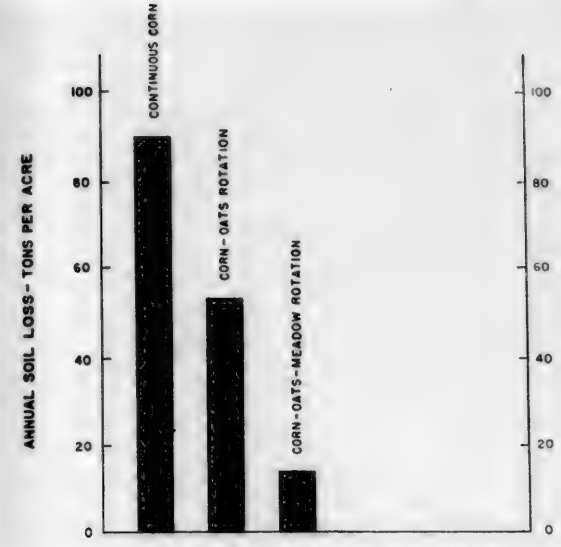

FIGURE 5-EFFECT OF CROPPING PRACTICES ON EROSION OF SHELBY SILT LOAM

per acre and 3.24, 0.38, and 0.12 inches of runoff, respectively, for the one-, two-, and 3-year stands (17).

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Teaching Basic Soil Principles Puts Conservation on the Land

WALLACE A. MITCHELTREE AND HARRY R. SLAYBACK

If the American farmer decides that he wants something he himself will see to it that he obtains it. Before he decides however, he wants to know the why and wherefore. He wants to reason it out for himself and not be told. He wants to know the basic fundamentals from which he can draw logical conclusions. If a farmer has a thorough knowledge of the basic principles of soil he will reason as to how to best manage it. Since fundamentals are difficult to teach and must be repeated and explained many times, many people must tell the same story. Who sees the farmer more frequently than the fertilizer dealer and salesman? Why not work with these men?

HOW MANY SQUARE YARDS in an acre? Yes, it can be calculated easily but can it be recalled? Probably not, because it is not a basic standard of measurement. The figure 43,560 flashes into the mind as the question is read but that is square feet. Why clutter up a brain with something as unimportant as the number of square yards in an acre? Exactly. Why not remember a few fundamentals and then reason out the various necessary answers? A genuine form of education. Why not teach the fundamentals? It will be slow but any good educational program is slow while the end result is always speeded up. Fifty years ago relatively few farmers were capable of dividing 43,560 by nine and finding the correct answer of 4,840 square yards for an acre; but things are different now.

Is there any good reason why farmers today should not learn the fundamentals in soil management? They should have a speaking acquaintance with such soil terms as pH, structure, texture, aggregation, infiltration, percolation, base exchange, buffer capacity, nutrients, trace elements, air-water relations, weathering, profile development, water movement, and land use.

The New Jersey Extension soils and soil conservation program is based on this idea. What is a Conservation Plan but a detailed program of good soil management! Why try to sell erosion control, water loss, drainage, and specific lime and fertilizer recommendations as we have in the past and clutter up a farmer's mind with a bunch of facts and figures that may not necessarily apply to his farm? Why not teach the fundamentals and let him reason the "why" and "how" for himself? Is it not possible that the farmer can develop his own Conservation Plan on the land as the need arises?

Consider the dairy and poultry farmers. These men understand a great deal about the anatomy of their beasts and birds and use this information daily in feeding and managing them as well as in treating their diseases. The poultry farmer is well acquainted with *"Laryngotracheitis."* He can pronounce it, spell it, recognize it, and treat it. Is this so much easier than "base exchange" or "buffer capacity?" We believe that the answer lies in the word *"soil."* Once the soil is appreciated as the real basis of all farm income it will be as well managed as any dairy herd or poultry flock. The easily spelled words "poor aggregation" and "erosion" will be recognized as symptoms of a disease that can be cured by good soil management.

The term "soil conservation" has been overworked. Soil conservation has come to mean strip cropping, terraces, crooked and point rows, along with such luxuries as fish ponds and tree planting. These are the things which manifest soil conservation. Why can't it mean such things as increased infiltration, more rapid percolation, greater exchange capacity, more favorable air-water relationships, stabilized aggregates and an adequate and natural nitrogen release?

It is axiomatic that contour strip cropping automatically calls for crop rotation and allowing the soil to enjoy a periodic rest. During this resting period the soil regenerates good structure, rebuilds aggregates, adds organic matter, and stores up nutrients, including trace elements.

Later nitrogen is released from this organic matter at a speed commensurate to the rate of growth permitted by the prevailing weather conditions. The end product of all this decomposition is "humic acid"—a brownish, sticky, gelatinous liquid that covers the soil aggregate causing it to be held together more tightly and thereby preventing it from breaking apart and washing away.

A farmer should think of contour strip cropping as we think of a football coach: A person who gathers good talent together to accomplish a given job. Contour strip cropping has many of the talents of good soil management under its banner. Cover crops which fit into a strip cropping plan are the source of a small

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Figure 1.—One of our best demonstrations to explain the physical properties of soil. The soil from the continuously cultivated plot slacks down while that from the rotated plot holds its shape. This illustrates the difference in stability of aggregation.

annual increment of organic matter. This produces a constant fresh supply for decomposition, giving in turn a constant supply of trace elements, nitrogen and humic acid. They also have a mechanical action in reducing wind and water erosion. It should also be possible for anyone to think of contour strip cropping in terms of good land use. This practice helps in matching the crop to the soil. Soil classes are often found incorporated with the slope, so that strips on the high droughty areas are planted to drought resistant crops while the lower and generally wetter areas are planted in crops that will tolerate wet feet.

An increase in the infiltration rate as a result of a more stable aggregation of the soil, which is obtained from good rotations and cover crops, reduces the amount of runoff. That water which does leave the field, does so more slowly due to the mechanical action of the contours and vegetative benefits of sods and cover crops. Soil erosion is reduced considerably by this method alone. Add to this a terrace which collects all the excess water at a point of harm and conducts it to a point of control. Erosion control by these methods can be complete. This overall system or combination of conservation tools impounds water on the higher droughty areas and at the same time prevents hundreds of extra tons from collecting in the lower wet areas.

Actually there are six basic practices of soil management involved in this system. They are (1) erosion control; (2) use of rotation; (3) use of lime; (4) use of fertilizer; (5) use of cover crops; and (6) matching the crop to the soil. Plenty of experimental data is available in Experiment Station bulletins and Soil Conservation Service Research reports from New Jersey that can be used for educational purposes.

Work done at the Beemerville Research Station indicates that when the rows were planted up and down the slope 4.98 inches of water ran off, taking with it 8.29 tons of soil from each acre. When the rows were planted on the contour, only 3.09 inches of water ran off, taking only 1.18 tons of soil. The contoured rows produced 1.4 more tons of corn silage an acre, 33 bushels more potatoes and 660 more ears of sweet corn, a story that pretty well sells itself.

Oren R. Neal, working at the Marlboro Soil Conservation Service Experiment Station near Freehold, N. J., found that just plain rotation and cover crops affected runoff, erosion and yield. A clover-timothy sod once every three years stabilized aggregation to such an extent that runoff was reduced from 4.88 inches on continuous tomatoes to 1.62 inches where tomatoes were grown only two years and sod the third. His sweet corn plots under the same treatment showed a reduction from

5.86 inches to 2.19 inches. Soil loss on the tomatoes was reduced from 5960 pounds per acre to 2210. On the sweet corn plots the soil loss was reduced from 4925 pounds per acre to 2250 pounds. Crop yields were correspondingly increased. Tomatoes grown continuously yielded 12.7 tons an acre, whereas those grown in rotation yielded 17 tons. Continuously cultivated sweet corn plots produced 7,650 ears an acre, whereas the yield on the rotated plots was 11,170 ears.

Vegetable farmers frequently say that they cannot afford to grow sod crops. Assume that there are two farmers each with three acres of identical land. The one follows a continuous cultivation program, the other a 3-year rotation. With tomatoes the continuous cultivation man will produce 3 x 12.7, or 38.1 tons. The rotation man will produce 2 x 17, or 34 tons. This 4.1 tons is a very small difference for an entire acre of land. With sweet corn the continuous cultivation farmer will produce 3 x 7,650, or 22,950, and the rotational man will make 2 x 11,170, or 22,340. 610 ears for the extra acre is hardly worth the time.

The economist has stated that to double the yield will increase the profit by four times. These yield increases are of the magnitude of 30 to 40 per cent. The Department of Agricultural Economics at Rutgers made a survey of canhouse tomato producers of New Jersey. It showed that those farmers who were producing state average yields were making an operator's labor earnings of $17 an acre.[1] It also showed that those who were producing 33 per cent above state average yields were making $48 an acre. Now back to our two farmers—the continuous cultivation man was making 3 x 17, or $51 a year on his 3-acre farm and our rotation man was making 2 x 48, or $96 a year. Allow the rotation man $15 a year cost of the establishment of the sod and he still has $81 a year as compared to $51 for the continuous cultivation man.

If one takes chunks of soil from the above-mentioned plots and immerses them in water, those from the continuously cultivated areas immediately slack down to muddy water, while those from the rotated plots hold their original shape. They do not slack down or muddy the water, yet they are wet all the way through. This indicates a stable structure that remains open during rainstorms and is highly receptive to water. These chunks will show the same response if they are placed on wire screens and water poured over them.

Today nobody argues against use of lime in crop production. The lime needs of the various crops and soils has been pretty well worked out. The use of fertilizer is standard practice. Both are necessary for production of optimum yields. Both are being used with even

[1] $17 an acre is a correct figure regardless of how low it may seem. Information taken from Page 7, Table 2—"Economic Factors in Processing Tomato Production" Carncross and Waller, A.E.117, June 1950—N. J. Experiment Station.

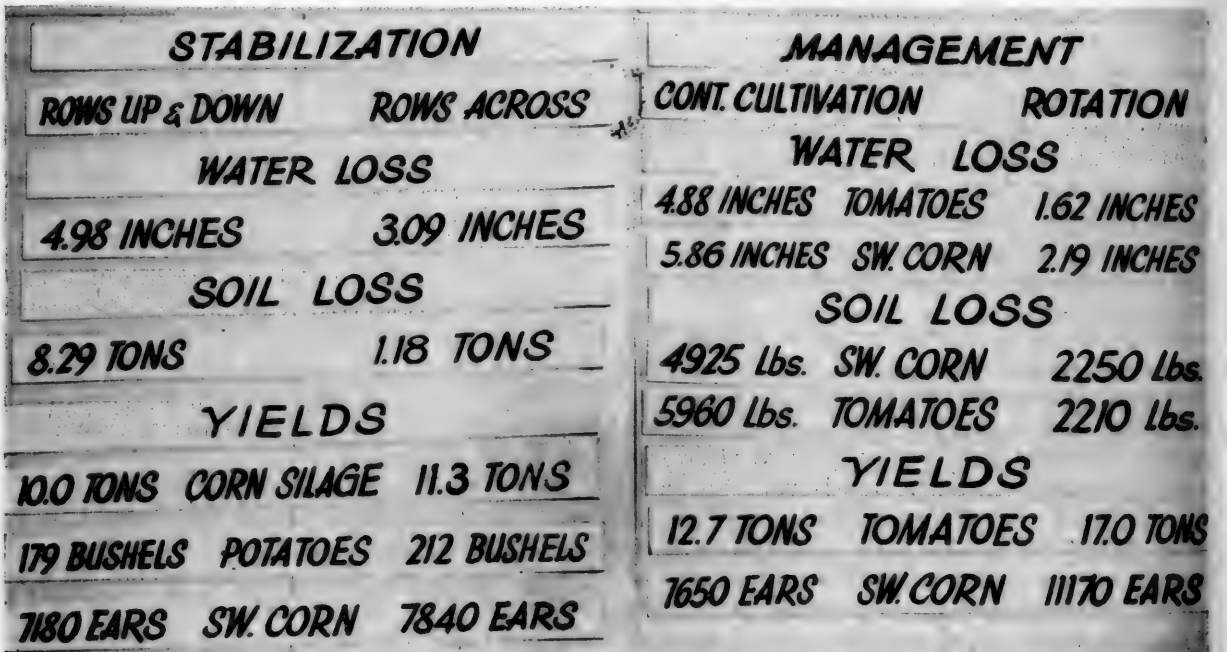

Figure 2.—A 3 x 6 foot sheet metal board supported by an easel holds printed cardboards approximately 3 x 36 inches. Each cardboard held on board by small magnets glued on back. These labeled strips are thrown on board in sequence to emphasize subject matter presentation.

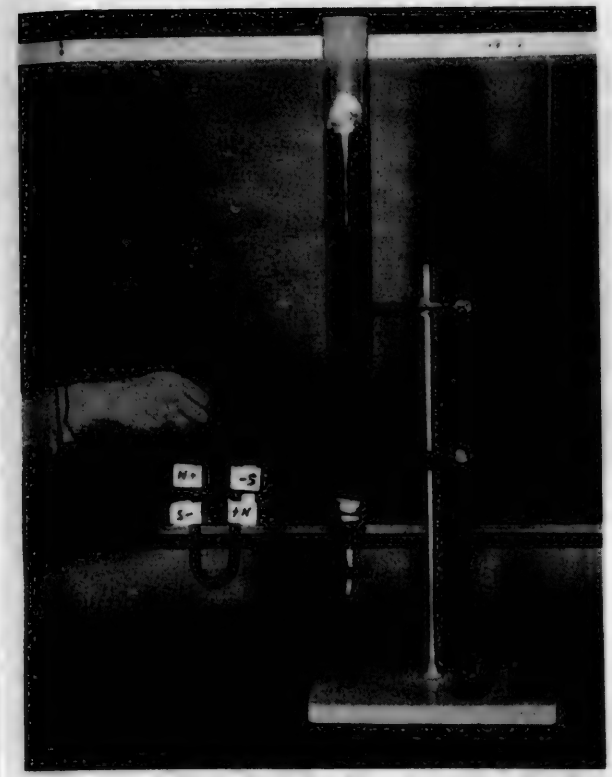

Figure 3.—A column of cation exchange resin used to explain base exchange in the soil. The column is 18 inches in length with a two-inch inside diameter. The horseshoe magnets show that unlike charges attract while like charges repel.

greater accuracy in crop production. But methods of soil management affect the fertilizer picture. Organic matter is endowed with exchange powers. If one increases the organic matter level of a soil by 0.5 per cent, he will increase the exchange capacity of an acre by an amount equivalent to that required to hold 1,000 pounds exchangeable potassium. This makes it possible to store up larger supplies of nutrient elements for crop use.

We can demonstrate this phenomenon of exchange capacity by use of a column of cation-exchange resin and a solution of ammonium nitrate. Before adding it to the column, ammonium nitrate is tested with Nessler's reagent to show ammonia and with diphenylamine to show nitrate. We then pour the solution into the column. As it runs out the bottom, we perform the same test, showing that the ammonium ion has been retained by the resin, whereas the nitrate ion has not. A pair of horseshoe magnets is used to illustrate the principle of electrical attraction of the ammonium ion for the resins and why the nitrate ion was repelled. If some fairly strong hydrochloric acid is now added to the column and the solution is tested as it emerges, it will show the presence of ammonium ions. This explains how the carbonic acid excreted by plant roots, replaces the adsorbed ions on the soil's exchange complex, hence exchange capacity.

Cover crops alone effect increases in yield as evidenced by work at the Marlboro Soil Conservation Research Station. A rye cover crop increased the yield of sweet potatoes by 26 bushels an acre, sweet corn by 1,500 ears, and tomatoes by 0.4 tons. This can be attributed to a reduction in runoff and erosion, and to the good effects of organic matter in the soil.

On the surface "*land use*" and "*land use capabilities*" for some reason are formidable terms. Why not call it "*Matching the Crop to the Soil*" because that is what it actually means. Generally speaking, most crops that are having a hard time making a decent yield are on land not suited to their requirements. They are not in their proper environment. Think of a nice flat piece of well drained fertile soil. Here there is little or no erosion hazard, no problem of matching the crop to the soil. The only management practices necessary are the use of lime, fertilizer, cover crops and rotation. Take the same piece of land and place it on a slope. An erosion hazard is induced and of course the steeper and longer the slope the greater the erosion hazard and the more intensive the control measures needed. Now instead of just four management practices there are five—the additional one being erosion control. When the slope is not too severe and with proper erosion control measures any crop can be grown. When the slope becomes greater, then cultivated crops must be abandoned and sod must be used most of the time as a control measure. Here a sixth management practice is involved, viz., matching the crop to the soil. It is plain to see that the more the land lays off level the more difficult it is to manage and the smaller the selection of crops that can be properly grown on it. It takes a smart man to manage the more difficult land and unfortunately most farms have only a small percentage of the easily managed land. Slope is not by any means the only factor to consider. Such things as drainage, hardpan, poor textural combinations, depth to bedrock and stoniness all contribute to the difficulty of management.

It is interesting to note that much of the difficult land can, if managed properly, produce just as many dollars per acre per year, and remain productive through just as many generations as the easily managed acres. Only those management practices which consider soil improvement as well as crop production should be condoned. Management practices based entirely upon crop production, lead only to disastrous results and increase the problem of later years. People concerned with soil management either in an advisory or practical sense, frequently feel that their main job is to manage the

Figure 4.—Central Jersey area field session on soil management for fertilizer dealers. Physical properties of soil and white potato yields on eroded and non-eroded soils were presented here.

soil for this year's crop only. We feel that their main job is to manage the soil in such a manner that it will be a better soil next year and at the same time produce a maximum crop this year.

An educational program involving these principles should not be too difficult. Why not work with the people with whom the farmer deals? Dealers and salesmen of the fertilizer and implement companies are at the farmer's beck and call and oftentimes advise him on his last minute decisions. They are interested in keeping both him and his farm strong for years to come. A salesman cannot sell a product unless he knows it inside out and from top to bottom. Not that a salesman should go out to sell soil management specifically, but the right word now and then in answer to farmer questions will do a great deal to put a good soil management program across.

Meetings especially designed for the local industrial representatives are now being conducted in New Jersey by the Extension Service. They are termed "Soil Management Field Meetings" and show how the "tools" in a Conservation Plan include a rotation that stabilizes soil aggregation, increases infiltration, reduces runoff, and prevents erosion. The industrial men are taught that conservation increases the soil's exchange capacity, aids in accumulating trace elements, provides a larger store of nitrogen, improves response to fertilizers, and makes for greater yields. Last, and most important, they are taught that good management practices will make New Jersey soils more and more productive as the years go by.

New Jersey Extension Service is teaching street level industry men, as well as farmers, the all-important fundamentals of soil management under the axiom that *"You can't improve soil without conserving it."*

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Book Reviews

SOIL MICROBIOLOGY. *By* SELMAN A. WAKSMAN. *John Wiley & Sons, Inc., New York. 1952. Pp. 356, figs. 130. Price, $6.*

This is a highly interesting book. It gives a modern interpretation of the science of microbiology as applied to soils. The book contains 16 chapters of which the first presents the history of microbiology, and the others deal with microbial population, specific organisms, plant decomposition, humus, carbon and nitrogen transformations, nitrogen fixation, mineralization of organic matter, relationships between higher plants and soil microorganisms, association and antagonistic relationships, disease-producing microbes and their control, manures, composts, microorganisms and soil fertility, and recent developments in this field of study. The first chapter is of special interst since it contains excellent photographs of 17 famous soil microbiologists. One cannot have a science without men of genius, and the men pictured in this chapter are those who are responsible for the origin and development of this highly important science. Dr. Waksman himself has made highly important contributions to this science in his work with antibiotics, which grew out of a lifetime of study of living entities in the soil. A bibliography is appended to each chapter. Excellent illustrations constitute a highly important part of of the book. All soil-plant scientists will want a copy close at hand for ready reference.

—FIRMAN E. BEAR, *New Brunswick, New Jersey*

SOIL CONSERVATION DISTRICTS IN ACTION. *By* W. ROBERT PARKS. *The Iowa State Press, Ames. 242 Pages. 1952.*

This is one of the very first books, if not the first, that describes in detail the unit of government known as a Soil Conservation District. From the opening chapter "Beginnings of the Soil Conservation District" to the last chapter "Future of the Soil Conservation Districts," the life development of the district movement in the United States is well charted.

An ample history gives the reader the background of district organization and the second chapter, "Nature of the Soil Conservation District" delves into such matters as the creation, legal positions and powers of districts, just to mention a few of the pertinent topics.

The third chapter, entitled "Gearing Local Districts Into National Conservation Program," describes the development and use of the District Program and Work Plan and explains the history as well as the present application of the so-called Cooperative Agreement. The place of various memorandums of understanding is also pointed out as well as the farm plan which districts have used to specify what the farmer has agreed to do on his own farm.

The fourth and fifth chapters deal with "Role of District Supervisors" and "Increasing Supervisors Role in District Administration" respectively. Both of these chapters get into the heart of local self government and feature the supervisor's participation in such activities as the planning and handling of equipment, priority decisions, group planning, annual reports, district use of funds, territorial division of district work and the actual calling on farmers by the supervisors.

The final two chapters discuss the "Value of the District in Achieving Soil Conservation" and "Future of the Soil Conservation Districts."

The Land Use Regulation phase of district laws is aptly described, and is further substantiated by examples and appropriate facts. The final chapter describes, as the author terms it, "Efforts to Integrate Conservation Activities" and other related information pointing to future district possibilities.

Professor Parks has done a very admirable job in collecting and assembling facts regarding districts. This includes such information as the number of districts, farms and acres in districts, numbers of trees and shrubs furnished districts by the Soil Conservation Service, allocation of state funds, description of work plans and programs and a host of other valuable information. He has also dotted the book with descriptive samples of district reaction and policy and has pointed out such trends as the relaxing of farm plan requirements, the accelerated use of groups for farm planning and similar information.

In my opinion he over stresses the relationship of the Soil Conservation Service and the influence of this agency on districts. This is understandably true for the early history of districts, but it does not appear logical to carry this theme throughout practically every page. Such statements as, "In substance, district supervisors are to be extra hands for the Service technicians. The supervisors are to bring in applications for farm plans. They are to arrange for educational and other types of meeting," seem to bear this out. In fairness to the author, he goes on to point out how the Soil Conservation Service is trying to get the governing bodies to assume more of their responsibilities, although the Service does appear to dominate almost every action.

Because the theme of the book emphasizes the Soil Conservation Service, it treats rather lightly, and sometimes not at all, the place of other groups in the total district program. For example, private industry and business in relation to the district effort is omitted. Bankers might feel slighted because they are left out of

the picture and although their present activity might be rather small in relation to the entire district program, they are a factor in the district operation.

The Farm Equipment Industry is going to some length and expenditure to secure the active cooperation of farm equipment dealers with their respective district. One rubber company is currently spending quite an enormous sum for a project designed and developed specifically to abet the district program. The same is true of some power companies, metropolitan newspapers and additional groups in the field of business and industry.

Other groups, such as State Soil Conservation Committees, State Departments of Agriculture, Conservation and Education, are also lightly mentioned. Perhaps some county school superintendents will be a bit chagrined because their local programs of cooperation with their district received no attention. In fact, the Program of Greater Service, which was created for the purpose of putting people to work for the district supervisors, might well have been featured in Professor Park's book.

In the final chapter the author poses these questions: "What will the soil conservation districts of the future be like? Will they become mere outlets for the conservation program of a national agency or will they continue to grow in independence and strength? How will they be geared in with the total conservation job for which the national government is responsible? What are the most promising potentialities of the district, and what are its limitations?" Only the districts themselves can answer these questions.

"Soil Conservation Districts in Action" is the first comprehensive treatment of districts and will make interesting and informative reading for supervisors and the people interested in their program.

—MORRIS E. FONDA, *Detroit, Michigan.*

PASTURE PRODUCTION AND MANAGEMENT. *By* R. H. LUSH. *The Blakiston Company, Inc., New York —Toronto, 1952. 191 pages.*

We often buy goods because of brand names. When I learned that Bob Lush had written a pasture book, I wanted a copy. It was my opinion that a man of his long experience in pasture work just could not turn out any thing but a good book on this subject.

"Pasture Production and Management" lives up to all that I expected. It has a wealth of pasture information packed into 191 pages. In addition to the "trademark" that the author's name puts on it, some 20 of the leading authorities in the country made contributions to the excellence of the book.

The chapter on the "History of Pastures" makes interesting reading for those of us who have enough interest to make us want to know, but who are a little too lazy to wade through a large number of library books to get such information. Pastures, as we learn from this chapter, have been important in the agriculture of the world and have contributed very substantially to the lives of people for more than 2,000 years.

Pastures are important in our own country. Many of us do not realize that 60 per cent of our land area, or 1,126 million acres, is in grassland. Two-thirds of this grassland is privately owned. Future agricultural opportunities lie largely in the field of grassland improvement—either in rotations with cultivated crops on our better lands or through better treatment of other grasslands. Soil conservation, increased food production, and greater farm income are all tied up in our future use of grass.

The average one of us knows most of the important pasture plants in his own locality. If you would like to expand your knowledge to all parts of this country, you can find brief descriptions of the principal pasture plants here for each section of the country. All of this can be found in about ten pages of easy reading.

The two chapters, "Establishing New Pastures" and "Management of Old Pastures," get down to earth and give some information with handles on it that we can get hold of and use. Fundamentals of land preparation, soil amendments, seeding, and the proper care of new seedings apply wherever new pastures are to be made. The management of old pastures is dealt with so realistically that no one could possibly assume that once a pasture is well started it can be used forever without further attention. Everyone interested in pastures should read this chapter.

Being in the South, I was interested in the chapter on supplementary pastures. We probably have more good plants for use in supplementary pastures than any other part of the country. The author gave experimental data to show the value of various temporary pastures. As a soil conservationist, I believe that this is a very fertile field for further research. We need to know how best to use perennial and reseeding pasture plants to fill in the weak links of our grazing program. We also need to know how to do this with the minimum amount of soil disturbance and resultant erosion on our sloping lands.

Two successive dry summers have taught us that irrigated pastures are not just something we read about farmers having "out West." Irrigation, particularly of dairy pastures, is a very live subject in the South. The chapter on irrigated pastures will be of particular interest to professional workers and to farmers in the South.

The chapter, "The Nutritive Value of Pastures," gives some excellent information that is needed by all

MANURE PILE OR GOLD MINE?

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Most of the vital elements in manure can be saved, and returned to the land, by proper manure-handling methods. Modern equipment turns this old unpleasant job into one that's fast and easy.

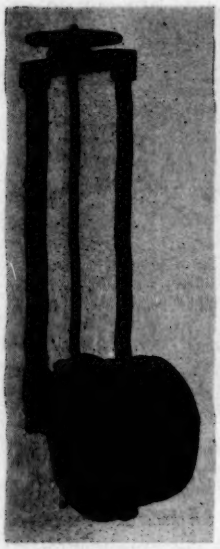
WHAT'S MANURE WORTH? It varies with prices of farm products, with soil types, and other conditions. On Miami silt loam in Ohio, a ton of shed-stored manure raised crop yields during a rotation by 18 bushels of corn, 5 bushels of wheat, and 500 pounds of clover hay per acre. In another trial, on Wooster silt loam, the comparable yield increases were 24 bushels of corn, 10 bushels of wheat, and 1,280 pounds of clover hay per acre.

Results might be much different under other conditions of soil type, weather, the crops grown, the kind of manure, and so on; but the fact remains—manure is valuable. A ton of average fresh manure contains around 500 pounds of organic matter, 10 pounds of nitrogen, 2 pounds of phosphorus, 8 pounds of potassium—all elements that cost money if you buy them in the bag.

**All data from experiment station records.*

JOHN DEERE

MOLINE ILLINOIS



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who are interested in pastures. Of particular importance is the discussion of what we usually call minor elements. Some of these are assuming considerably more importance than most of us once realized. I was glad to see the emphasis placed on certain management factors as related to nutritive value and palatability of pasture forage. Use of soil amendments and proper association of grasses and legumes strongly influence both nutritive value and palatability.

Separate chapters were written on pastures for dairy cattle, beef cattle, sheep and goats, horses and mules, swine, and poultry. This is a good thing, too, because these different classes of livestock vary in their pasture requirements. To me, one of the best features of these chapters is the amount of information on the management of both pastures and animals that is woven into them. Probably in no other part of the book does the author draw so largely on his own wealth of good pasture and animal husbandry experience and "know how."

"Utilization of Grassland," is a particularly good chapter. Hay and silage of good quality help to fill in the gaps on the annual livestock feeding program. New developments in making grass silage are well covered. New hay-making methods are even more revolutionary than grass silage. We have grown so accustomed to seeing one man operating a pick-up baler that most of us have forgotten our earlier hay-baling experiences when it took all the men, mules, and pitchforks in a community to operate a mule-powered, hand-fed baler. Seed production also is important. Seed is often a good source of income and it is always essential to the perpetuation and expansion of a grassland program. Allowing perennial plants to make seed is of vital importance in maintaining vigorous stands.

No pasture book that fails to tell us what to do about pasture pests and diseases would be complete. Insects, rodents, animal parasites, and plant diseases are factors with which every pasture man must deal. Here again, the author gives us the benefit of some things he learned through long experience.

Weed control may be simplified by new chemical sprays, and we certainly need an effective weed-control program. Specific treatments for different kinds of weeds are given in chapter 17. But, before you skip all the way over to the chemical weed treatments read the excellent discussion in the first part of this chapter on weed prevention and pasture mowing.

Much useful information is tabulated in the back of the book. This includes the pasture fertilizer recommendations of the different state agricultural experiment stations, composition of different forages, plant food removal in different forages, composition of farm manures, pasture acreage by states, and a bibliography of pasture reference material.

If you are interested in pastures, you'll like "Pasture Production and Management."

—R. Y. BAILEY, *Spartanburg, S. C.*

Methods of Statistical Analysis. *By* CYRIL H. GOULDEN. *2nd Edition. John Wiley & Sons, Inc. New York. 476 Pages. $7.50. 1952.*

The subject matter in this book is slanted toward the student who is now, or will eventually be, a research worker. It gives detailed methods for the statistical analysis of experiments of basic design, geared to give the reader a firm command of underlying principles.

A Conservation Land Use Plan for the Town of Groton, Massachusetts. *Bulletin No. 175, Massachusetts Forest and Park Association, 3 Joy Street, Boston 8, Mass. 1952. 12 pages.*

The History and Future of Flood Control. *By* GEORGE R. SCHNEIDER, *Corps of Engineers, U. S. Army, Little Rock, Arkansas. 1952. 98 pages.*

The Soil That Went to Town. *By* C. W. GEE, *Soil Conservation Service, U.S.D.A., Washington, D. C. 1952. 20 pages. 10 cents.*

Sharptails into the Shadows. *By* FREDERICK *and* FRANCIS HAMERSTROM *and* OSWALD E. MATTESON. *Game Management Division, Wisconsin Conservation Department, Madison 2. 1952. 36 pages.*

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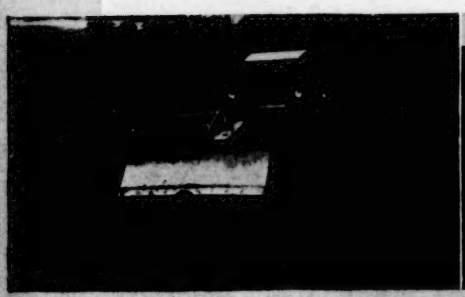
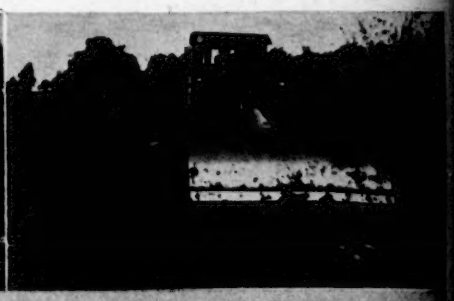


Building terraces

Shaping waterways

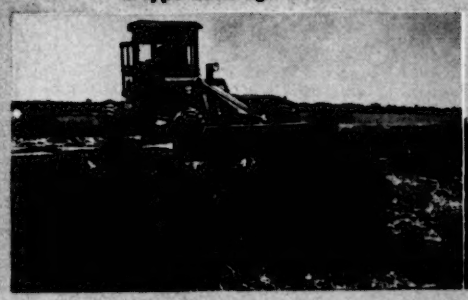


Cutting outlet ditches

V-type drainage ditches

Shallow drainage ditches

Tile ditches



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